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(54) **METHOD AND FILLING UNIT FOR FILLING A BOTTLE WITH A FOOD LIQUID**

(57) A filling unit (1) for bottle filling machines has a tank (9) adapted to contain a food liquid to be bottled, a filling device (10) for filling by level, which includes a body (12), an outer tube (16) extending through the inner cavity (14) of the body (12), and an inner tube (18) arranged coaxially with the outer tube (16) and movable in relation to the latter; the unit (1) also comprising a centring cone (22) arranged coaxially with the outer tube (16) and configured to provide a seal against the upper end of the neck of the bottle to be filled, a first shutter (24) which is arranged vertically movable and is configured to seal the first tube (16), an operating unit (26) designed to control the vertical movement of the first shutter (24), and a flow meter (40) adapted to emit a delivery signal for controlling the level filling device (10) .

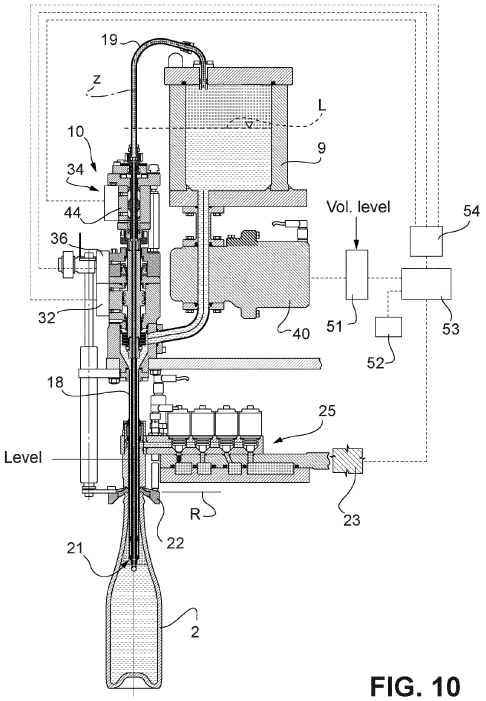

FIG. 10

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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This Patent Application claims priority from Italian Patent Application No. 102021000016190 filed on June 21, 2021.

TECHNICAL FIELD OF THE INVENTION

[0002] The present invention relates to a method and a filling unit for filling a bottle with a food liquid.

STATE OF THE ART

[0003] As is known, the filling of bottles with food liquids is generally classified into two categories based on the technology used to detect that the right amount of liquid has been delivered, and precisely, filling by level and filling by volume.

[0004] In turn, filling by level is categorised into physical filling by level, obtained by inserting in the bottle a duct (also known as a "vent tube") which allows the gas to exit the container during the filling and causes the filling to stop at a certain level, i.e., at the height of insertion of the duct in the neck of the bottle, and filling by level with a sensor, where a sensor causes the delivery to stop when it gets wet with the liquid.

[0005] Volumetric filling is also categorised into physical volumetric filling (obtained by pre-filling a known-volume chamber and then transferring into the container the dose entered into said chamber), volumetric weight filling (a load cell stops the filling of the container when the desired weight is reached), and volumetric filling with a flow meter, in which a flow meter stops the filling when the filling valve has delivered the desired volume or mass into the container to be filled.

[0006] In addition, the filling valves differ according to the liquid to be processed.

[0007] In particular, in the case of flat or viscous liquids, the filling can be carried out by sealing the container on the filling valve, or without contact between the container and the valve. The product is usually bottled at atmospheric pressure, under light pressure or under slight depression.

[0008] In the case of carbonated liquids, on the other hand, the container is normally sealed on the filling valve and pressurized. The filling takes place at a pressure well above atmospheric pressure, to prevent excessive foaming during the filling. This type of filling is also commonly referred to as "isobaric filling".

[0009] Valves suitable for filling with carbonated liquids can usually also be used for filling with flat liquids and, with some construction variants, also with viscous liquids, whereas valves suitable for filling with flat products and valves for viscous liquids cannot be used for filling with carbonated liquids.

[0010] Traditional solutions suffer from some inherent limitations.

[0011] In particular, physical level filling valves have the drawback that, when the filling of a bottle is completed, the gas return duct (the so-called "vent tube") also inevitably fills with liquid until it substantially reaches the level of the liquid in the valve feeding tank. Two examples of bottle level filling valves are known from EP 2958851 A1 and EP 2903929 A1, both in the name of the Applicant.

[0012] In order to fill the next bottle, the gas return duct must be emptied, and to do this the liquid in the return duct can be dropped/pushed into the next bottle or sent back to the feeding tank or to a secondary tank by overpressure in the bottle or vacuum suction.

[0013] Depending on the internal diameter and length of the gas return duct and on the height of the head, the volume of the liquid contained in the gas return duct may not be negligible, in some cases reaching 20-30 ml.

[0014] For this reason, in both cases there is a risk of contamination, in the first case of the next bottle, and in the second case, of the liquid contained in the main tank.

[0015] In the volume filling mode, in which the stopping of the filling is determined by the signal coming from the flow meter when the correct dosage is reached, and not by the reaching of the height at which the gas return duct is, the gas return duct is kept at some distance from the final level of the liquid in the bottle at the end of the dosing.

[0016] However, although this necessary configuration on the one hand prevents the liquid from rising into the gas return duct, on the other hand, it is not satisfactory as the filling is heavily influenced by the geometry and size of the bottle neck. In fact, in the presence of containers that have deep filling levels (i.e., very far from the mouth) and a section in the level area that is wide compared to the section in the mouth area, it is very difficult to keep the liquid in contact with the inner walls of the bottle, which is essential when filling with liquids that tend to foam. The foam dissolves over time but this imposes relatively long wait times, which increase the bottle filling time and thus reduce the production rate of the machine.

[0017] In addition, the known volume filling valves normally require the liquid shutter to be at a certain distance from the liquid outlet mouth, especially for construction/dimensional reasons. This construction form gives rise to a chamber with a non-negligible volume between the liquid shutter and the outlet mouth. At the end of the filling of a bottle, due to adhesion, a certain amount of liquid remains trapped in the aforementioned chamber, which must be appropriately managed in order to avoid loss of dosage accuracy (due to the random behaviour of the liquid trapped in the chamber) or, in the case of high-pressure filling, it must be prevented that during the depressurization of the container the liquid comes out of the chamber violently, thereby striking the liquid already in the bottle and resulting in the formation of foam.

[0018] In order to overcome these drawbacks, the prior art generically contemplates a number of solutions, including the one proposed, for example, in patent document no. US6817386 concerning a volumetric valve for

carbonated liquids. In this solution, an additional duct, with its shut-off valve, has been added to the traditional volume valve layout to allow gravity emptying of this chamber at the end of the filling.

[0019] However, this solution has the flaw that the emptying of this chamber takes time and therefore results in a loss of production yield.

[0020] Furthermore, the construction of the valve is considerably complicated, thus making its sanitization more difficult.

[0021] These limitations, understandably, affect the overall efficiency of the filling procedure, as there are (for both filling modes) sub-optimal application conditions where the performance of the procedure is poor.

SUBJECT AND SUMMARY OF THE INVENTION

[0022] One object of the present invention is to provide a filling unit for filling a bottle, which allows the above problems to be solved in a simple and inexpensive way.

[0023] A particular object of the present invention is to provide a filling unit, which allows precise dosing when it operates by level filling, thereby significantly reducing or eliminating the contamination problem due to the presence of liquid in the return duct following the filling of each of the bottles, and avoiding additional operations such as levelling.

[0024] A further object of the present invention is to provide a filling unit, which is capable of either filling by level or by volume and which, when filling by volume, allows the path followed by the liquid inside the bottle to be controlled in a simple way.

[0025] According to the present invention, a filling unit for filling a bottle with a food liquid is provided, as claimed in claim 1.

[0026] The present invention further relates to a method for filling a bottle with a food liquid.

[0027] According to the present invention, a method for filling a bottle with a food liquid is provided, as claimed in claim 9.

[0028] The present invention essentially proposes a hybrid feeding unit, which allows the advantages of both traditional filling machines to be combined in a single machine, so that the filling mode can be easily adapted to the different conditions of use.

[0029] This results in a filling unit which can fill both by level and by volume, so that the user can conveniently select the most advantageous filling technology according to the type of container and the type of liquid to be bottled.

[0030] At present, the solutions on the market would force the user to have two separate filling machines, each with a different filling technology. This, of course, leads to a significant increase in the costs of purchasing and operating the plant, as well as in the space on the production line.

[0031] The invention aims to find a simple, compact and highly hygienic construction form that perfectly combines the two filling technologies, without their coexistence restricting the functionality of each, indeed the combination of the two allowing additional advantages.

[0032] A filling unit according to the present invention allows the drawbacks of the prior art to be limited.

[0033] In fact, even if the unit is used in the physical level filling mode (i.e., the level in the bottle stops hydraulically when the gas return duct is reached), the liquid in the gas return duct can be prevented from reaching the level in the tank, or in any case, the height reached by the liquid in the return duct can be significantly limited by closing the liquid flow-through shutter when the flow meter detects that a volume equal to or close to that required to reach the desired level has been delivered.

[0034] In other words, the unit according to the invention allows operation in the level filling mode, thus limiting the amount of excess liquid that is necessarily delivered in traditional level filling valves. This makes it possible to minimize the amount of liquid in the gas return duct, irrespective of the physical volume of this circuit and the height of the head.

[0035] Moreover, at the end of the cycle of level filling of a bottle, it is possible to check, by means of the flow meter, whether at least the nominal minimum quantity for the bottle has been dosed. In this way, it is possible to detect any bottles not filled correctly, for example due to the failure or partial opening of the liquid shutter or the gas return shutter or other anomalies, without adding specific sensors to monitor the open/closed status of the various pneumatic actuators, with clear economic savings and constructive simplification.

[0036] In addition, a unit according to one embodiment of the present invention offers the advantage during volume filling of being able to regulate/choose the best liquid delivery area inside the bottle neck, both to maximize the flow rate of the valve and to limit the formation of foam during the filling. In fact, the position of the liquid outlet and gas return shutters can be conveniently changed by the operator, ranging from a few millimetres above the final level obtained with the dosage up to the mouth of the container. The advantage is evident, for example, in the aforementioned case of containers having deep filling levels (i.e., very far from the mouth) and a section in the level area that is wide compared to the section in the mouth area. In fact, by being able to move the liquid outlet mouth between the level reached by the dosed liquid and the bottle surface, a smaller section of the container is used to obtain advantageous outflow conditions, i.e., complete adhesion of the fluid threads to the inner surface of the bottle. On the other hand, in the case of containers with a very narrow mouth section and subsequent widening in the neck and shoulder, the product can be delivered immediately below the narrow section, avoiding loss of filling yield.

[0037] It should be noted that this important advantage is inherent in the constructive form of the invention. In order to achieve the same advantage (adjustable product outflow area) in the known volumetric valves, additional

means of adjustment, adjustable flow diffusers, etc., would have to be added, with clear negative effects on the complexity and cost of the devices.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038] The invention will now be described with reference to the accompanying drawings, which illustrate some nonlimiting embodiments thereof, in which:

- Figure 1 is a schematic longitudinal section view of a preferred embodiment of a multi-function filling unit for filling machines, according to the present invention;
- Figure 2 is a schematic longitudinal section view of a multi-function filling unit for filling machines, according to a further embodiment of the invention;
- Figure 3 is a schematic longitudinal section view of a detail in Figure 1, illustrating an open condition of the delivery tube to be inserted in a bottle to be filled;
- Figure 4 is a schematic view of the filling assembly in Figure 1, illustrating a first step of the filling process, wherein the end of the delivery tube (in this embodiment including two concentric tubes identifying an outflow duct for the filling liquid and a gas return duct, respectively, each occluded by a respective shutter) is inserted in the bottle to be filled, which is still empty;
- Figure 5 is a schematic view of the filling assembly in Figure 1, illustrating a second step of the filling process, wherein the two shutters are opened to allow the fluid to enter and the gas to exit the bottle;
- Figure 6 is a schematic view of the filling assembly in Figure 1, illustrating a third step of the filling process, wherein the fluid level has reached the end of the delivery tube (more precisely, of the gas return tube), causing the delivery to stop;
- Figure 7 is a schematic longitudinal section view of a detail in Figure 1, illustrating an assembly configuration in which the shutter of the liquid outflow tube is closed, and the delivery of fluid between the tank and the bottle is inhibited;
- Figure 8 is a schematic longitudinal section view of a detail in Figure 1, illustrating an assembly configuration in which the shutter of the liquid outflow tube is wide open, and full delivery of fluid is allowed between the tank and the bottle.
- Figure 9 is a schematic longitudinal section view of a detail in Figure 1, illustrating an assembly configuration in which the shutter of the liquid outflow tube is partially open, and a partial delivery of fluid is allowed between the tank and the bottle; and
- Figure 10 is a figure similar to Figure 6 and shows, schematically and essentially in blocks, a command-and-control assembly of the bottling unit in Figure 1.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

[0039] With reference to Figure 1, a filling unit 1 for filling machines, for filling containers in general, and a bottle 2 in particular, with food liquids comprises a tank 9 adapted to contain a food liquid to be bottled and a filling device 10 for filling by level, which includes a fixed body 12 having an inner cavity 14 extending axially through the body 12. The device 10 then includes an outer tube 16, which communicates with the inner cavity 14 of the body 12 and protrudes downwards beyond the body 12 by such an amount as to be inserted, in use, inside the bottle 2, as shown in Figures 4 and 5.

[0040] According to a variant not shown, the outer tube 16 protrudes just below the body 12 to cooperate as much as possible with the free end or the mouth R of the neck of the bottle 2.

[0041] Still in the example described, the device 10 also includes an inner tube 18, which is arranged coaxially with the outer tube 16, is mobile with respect to the outer tube 16, extends with a lower section thereof inside the outer tube 16 and protrudes upwards relative to the outer tube 16, so that its upper end, when the filling unit 1 is fitted to the machine, is above the level L of the liquid contained in the tank 9.

[0042] The outer tube 16 and the inner tube 18 delimit therebetween an annular duct 20 which extends to the lower end of the outer tube 16 and ends with an outlet mouth 21, through which the liquid contained in the tank 9 can flow out to fill the bottle 2.

[0043] Conveniently, the inner tube 18 is configured to allow the gas to flow back from the bottle 2 to the tank 9.

[0044] The device 10 also comprises a centring cone 22 which is arranged coaxially with the outer tube 16 and the inner tube 18 and is configured to provide a seal against the upper end of the neck of the bottle 2 to be filled (Figure 4). The height position of the centring cone 22 along the axis z and thus the insertion depth of the inner tube 18 inside the bottle 2 are continuously adjustable by means of an adjustment device 23, which is per se known.

[0045] The device 10 further comprises a shutter 24 which is arranged vertically movable and is configured to seal the outlet mouth 21 of the annular duct 20. In the example described, the shutter 24 is arranged in the vicinity of the lower end of the inner tube 18 and is adapted to cooperate with the lower end of the outer tube 16 to open/close the outlet mouth 21 at the bottom.

[0046] According to a different embodiment, the shutter 24 is arranged at the inlet of or along the outer tube 16 or at the outlet of the inner cavity 14.

[0047] In the example described, the shutter 24 is configured to be inserted, in a condition of use of the filling assembly 1, in the bottle 2, i.e., below the mouth R of the bottle 2 to be filled.

[0048] The device 10 also includes an operating unit 26 designed to control the vertical movement of the shut-

ter 24.

[0049] Still referring to Figure 1, the filling unit 1 also comprises a duct 30 designed to place the inner cavity 14 in fluid connection with the tank 9, and a flow meter 40 designed to measure the flow rate of fluid passing through the duct 30 and through the outlet mouth 21 of the annular duct 20.

[0050] According to a variant not shown, the flow meter 40 is arranged along the outer tube 16 or at the inlet of the annular duct 20, and in general, in such a position as to measure the volume of liquid passing through the outlet mouth 21.

[0051] By way of example, magnetic-inductive flow meters for filling with conductive liquids, or mass flow meters for filling with conductive and non-conductive liquids may be used.

[0052] According to a preferred embodiment, the shutter 24 is fixed to the inner tube 18, and the assembly formed by the inner tube 18 and the first shutter 24 is vertically movable between an opening position, wherein it opens the outlet mouth 21 to the maximum to allow the liquid contained in the tank 9 to flow downwards and fill the bottle 2, and a closing position, wherein it occludes the outlet mouth 21 at the bottom, thus preventing outflow of the liquid from the annular duct 20.

[0053] With reference to Figure 7, the operating unit 26 of the device 10 conveniently comprises a first linear actuator 32, adapted to control the vertical movement of the first shutter 24, and a movement head 34 integrally movable with the inner tube 18 along the axis of the latter.

[0054] The inner tube 18 may be conveniently provided, in its upper part, with an extension 19, in the form of a duct extended above the level L of the fluid in the tank 9. This extension 19 substantially extends the tube 18 until it is in fluid communication with the tank 9, so that the gas flowed back through the second tube 18 is returned to the tank 9.

[0055] According to one embodiment (shown by way of example in Figure 2), the extension 19 flows into a secondary tank 9a, separated from the tank 9 and capable of collecting any fluid residues rising up the tube 18, so that the latter do not re-enter the tank 9, with the risk of contaminating it.

[0056] Finally, the device 10 comprises a valve assembly 25, which is per se known and comprises a plurality of valves, which are preferably pneumatically controlled and configured to start and stop the various steps of the bottle filling cycle. Preferably, but not necessarily, the device 23 acts on a support frame for these valves.

[0057] In the filling unit 1 according to the present invention, the presence of the flow meter 40 allows the quantity of liquid introduced to be measured precisely and it is used, as will be better described below, to control the device 10, for example, to prevent the liquid from flowing back into the gas duct, or to limit it to a negligible amount, or to control the travel path of the liquid entering the bottle 2.

[0058] However, due to the inherent inertia of the system, there may be a certain response delay between the moment when the flow meter 40 detects that the optimum dose has been reached and the moment when the first shutter 24 actually closes. To limit this delay, it would be advisable to choke the passage section of the first shutter 24 when the level of the liquid in the bottle is close to that necessary to reach the desired level. In this way, reducing the passage section of the mouth 21 allows the valve 10 to be closed more quickly, thereby reducing the system response delay.

[0059] For this purpose, when the level of the liquid in the bottle is close to the desired level, it is convenient to partially retract the tube 18 carrying the first shutter 24, so that the closing stroke of the first shutter 24 is reduced, and therefore the occlusion of the annular duct 20 is quicker, when the system detects, by means of the flow meter 40, that the quantity of liquid required to reach the desired level in the bottle has been delivered.

[0060] To achieve this, the operating unit 26 may conveniently comprise a first linear actuator 32 adapted to control the vertical movement of the first shutter 24, a movement head 34 integrally movable with the inner tube 18 along the axis of the latter, and a second linear actuator 36 axially interposed between the first linear actuator 32 and the movement head 34.

[0061] This second linear actuator 36 is movable between an inactive position in which it is at a maximum axial distance D_0 from a lower face of the movement head 34, and an active position in which it engages said lower face of the movement head 34. The maximum axial stroke M_0 of said second linear actuator 36 between the active and inactive positions shall have a value between the value of the axial stroke So of the movement head 34 between said opening and closing positions of the first shutter 24 and the value of said maximum axial distance D_0.

[0062] Conveniently, the filling device 10 comprises at least one support column 38, fixed relative to the body 12 and extending along an axis parallel to and not coinciding with the longitudinal axis z of the body 12. This support column 38 comprises two abutments 38a, 38b, against which the movement head 34 in the opening position of the first shutter 24 and the second linear actuator 36 in the active position abut, respectively.

[0063] According to one embodiment, the movement head 34 comprises a flange 34a which can slide along the support column 38 integrally with a buffer 34b which, in a closed position of the first shutter 24 (i.e., in an axially retracted condition of the second tube 18), is located at a distance So from the upper abutment 38a.

[0064] Similarly, the second linear actuator 36 can also slide along said support column 38, and shall be located, in the closed position of the first shutter 24, at a distance M_0 from the lower abutment 38b.

[0065] The above configuration allows the passage section of the first shutter 24 to be choked so that the flow of liquid through this first shutter 24 can be adjusted more precisely when the level has nearly reached the

first shutter 24.

[0066] In fact, in a closing configuration of the filling valve or device 10 (illustrated by way of example in Figure 7), the first shutter 24 is axially retracted upwards, so as to occlude the outlet mouth 21 of the annular duct 20.

[0067] In this configuration, the movement head 34 (connected to the second tube 18, which carries the first shutter 24 at the tip) is raised upwards to the maximum, and the second actuator 36 is in a distal position with respect to a lower face of said movement head. The potential downward stroke of the movement head 34 will be So (i.e., equal to the maximum stroke of the first shutter 24 of the annular duct 20, when open), the initial distance of the second actuator 36 from the lower face of said movement head 34 shall be D_0, and the potential upward stroke of the second actuator 36 shall be M_0.

[0068] In the fully open position of the first shutter 24 (a configuration in which the second tube 18 is in its lowest downward position), the movement head 34 will have travelled the full downward stroke So (in the example shown, the buffer 34b associated with the flange 34a will have abutted against the upper abutment 38a of the support column 38), while the second actuator 36 will have remained stationary in its initial position (in the example shown, the second actuator 36 rests on a bracket 33, fixed relative to the body 12 of the filling device 10). As a result, the new distance of the second actuator 36 from the lower face of the movement head 34 will have become $D_1=D_0-So$, as shown by way of example in Figure 8. In geometric construction, $M_0 > D_1$.

[0069] When the level of the liquid introduced into the container is close to the expected filling value (for example, this can be detected by the flow meter 40 based on a comparison between the preset target value and the quantity of fluid passed into the container, the passage of which from the tank 9 will have been detected by the flow meter 40), a reduction in the passage section of the annular duct 20 and a partial axial retraction of the first shutter 24 shall be appropriate in order to maximize the closing speed in the last delivery step.

[0070] In this configuration, the second actuator 36 will have travelled the full upward stroke M_0 (in the example shown, the second actuator 36 will have abutted against the lower abutment 38b of the support column 38).

[0071] As a result, the second actuator 36 will have engaged and lifted the movement head 34 (and therefore also the first shutter 24) by an amount $S_1 = M_0-D_1 < So$.

[0072] This will result in a partial lifting of the first shutter 24, which will therefore be nearer to the fully closed position.

[0073] According to one embodiment, the lower face of the movement head 34 is carried by a ring nut 35, coupled to the movement head 34 and axially adjustable so as to vary said maximum distance D_0. This ring nut 35 will act as an axial extension of the movement head 34.

[0074] According to one embodiment, the filling device 10 further comprises a second shutter 42, which is arranged vertically movable and is configured to seal the inner tube 18, and a third linear actuator 44, which is adapted to control the vertical movement of the second shutter 42, the first linear actuator 24 and the third linear actuator 44 being fitted in series with each other.

[0075] As shown by way of example in Figure 3, the second shutter 42 can be carried by a stem 43, which can be axially moved by the third linear actuator 44 and is coaxial with the second tube 18, so that it can form with the latter a second annular duct 45 for the return of the gas from the container.

[0076] Throughout this description and in the claims, terms and expressions indicating positions and orientations, such as "longitudinal", "vertical" or "axial", shall refer to the longitudinal axis z.

[0077] It is clear from the above that the described unit 1 makes it possible to carry out either a filling by level or a filling by volume by only using a level filling device and controlling it on the basis of a delivery signal proportional to the volume delivered emitted by the flow meter 40.

[0078] In particular, with reference to Figure 10, the unit 1 comprises a command and control assembly indicated with 50, which in turn comprises a block 51 configured to receive a delivery signal emitted by the flow meter and proportional to the volume of liquid passing through the annular duct 20 and the outlet mouth 21, and a memory block 52 which stores, for each type of bottle, the volume of liquid envisaged to reach the desired level, when filling by level, and the envisaged volume of liquid, when filling by volume. The assembly 50 further comprises a comparison block 53 configured to compare the volumes detected by the flow meter 40 with those stored in the block 52, and a block 54 for controlling the device 23 and the actuators 32, 34 and 36.

[0079] This way, when filling by level with the inner tube 18 at a height such as to define the desired level, the block 54 in response to the delivery signal controls the actuator 32 or the actuator 44 at the moment when the volume of liquid delivered is equal to or close to the volume of liquid envisaged for the container, so as to move the shutter 24 towards its closed position, thereby preventing the escape of additional liquid in order to zero or limit the amount of liquid that may flow back upwards into the tube 18. "Equal to or close to" means when the volume of liquid delivered reaches a volume between approximately 95% and 100% of the theoretical volume envisaged for that particular container. This percentage value varies mainly as a function of the following factors: response times of the device 10, type of liquid, internal shape of the container in the level area. Experimentally, it has been found that by using the assembly 50 according to the invention, the amount of liquid flowing back upwards into the inner tube 18 is in the range of 2-3 ml, thus about 1/10 of the volume flowing back upwards with a level valve of the known type.

[0080] The absence or the very low quantity of liquid in the inner tube 18 eliminates or reduces all at once the problems associated with the liquid pollution in the bottle or in the tank 9 and avoids the levelling operation nec-

essary to remove as much as possible the liquid from the gas return duct.

[0081] After a series of openings and closings of the outlet mouth 21 or after the filling of each bottle 2, the comparison block 53 compares, instantaneously or at the end of the delivery, the liquid volume(s) measured by the flow meter 40 with the volume(s) envisaged to reach the desired level in the bottle and generates a failure or alarm signal if it detects a difference between the volumes. This makes it possible to monitor the correct functioning of the various parts making up the assembly 10 and to intervene promptly by keeping the envisaged level in each bottle or the envisaged volume of liquid constant. Not only that, but this control makes it possible to intervene promptly in the event of the bottle breaking or bursting during the filling.

[0082] Regardless of whether a filling by volume or a filling by level is carried out, the comparison between the delivered volume and the envisaged volume made by the block 53 allows the actuator 36 to be controlled via the block 54 in order to choke the passage section of the outlet mouth 21 when the volume of liquid measured by the flow meter 40 is close to the volume of liquid envisaged both to reach the desired level and to fill by volume.

[0083] In the case of filling by volume, during a step of setting the unit 1 and at each production change, the assembly 50 makes it possible to accurately check the volume actually delivered through the outlet mouth 21 and the exact level reached by this liquid and, via the block 54, to control the device 23 so as to arrange the same outlet mouth 21 and the outlet of the inner tube 18 above this level and to adjust vertically and continuously the distance of the outlet mouth 21 in the space between the determined liquid level and the upper end R of the bottle 2 so as to cause the fluid threads of the liquid supplied to the bottle to adhere and remain adherent to the inner surface of the bottle whatever the geometric and dimensional characteristics of said inner surface and the characteristics of the liquid delivered.

[0084] Compared to the known solutions, the presence of foam in the bottle is thus eliminated and, on the one hand, the production rate is considerably increased, and on the other hand, the presence of buffer chambers near the outlet mouth 21 when filling by volume is eliminated.

Claims

1. A filling unit (1) for filling a bottle with a food liquid; the unit comprising:

a tank (9) adapted to contain a food liquid to be introduced into the bottle;
a filling device (10) for filling by level, which includes:

a body (12) having an inner cavity (14) which extends vertically through said body (12);
an outer tube (16) which communicates with the inner cavity (14) of the body (12), protrudes downwards with respect to the body (12) and has a lower terminal section configured to guide the liquid into the bottle to be filled;
an inner tube (18), which is arranged coaxially with the inside of the outer tube (16), has a lower section protruding outside the outer tube and is configured to be inserted inside said bottle, protrudes upwards relative to the outer tube (16), so that its upper end, when fitting the filling assembly (1) on the machine, is above the level (L) of the liquid contained in the tank (9), the outer tube (16) and the inner tube (18) delimiting an annular duct (20) which extends to the lower end of the outer tube (16) and through which the liquid contained in the tank (9) flows downwards to fill the bottle;
a centring cone (22) which is arranged coaxially with the outer tube (16) and the inner tube (18) and is configured to provide a seal against the upper end of the neck of the bottle to be filled;
a first mobile shutter (24) configured to close the annular duct (20) in a sealed manner,
a second shutter (42) configured to close the inner tube (18) in a sealed manner;
first operating means configured to control the movement of the first shutter (24);
second operating means configured to control the movement of the second shutter (42);
third operating means (23) configured to vary the height position of said lower terminal section of the inner tube inside said bottle; the filling unit (1) further comprising a flow meter (40) adapted to measure the volume of fluid passing through said annular duct (20) and configured to emit a delivery signal proportional to the volume delivered; and command and control means configured to emit a command and control signal of said second or third operating means in response to said delivery signal.

2. **-** The unit according to claim 1, **characterized in that** said outer tube has a lower terminal section configured to be inserted inside a bottle to be filled, **in that** said inner tube extends with a lower section thereof inside the outer tube (16) and **in that** said first shutter (24) is arranged in the vicinity of the lower end of the inner tube (18) to cooperate with the lower end of the outer tube (16) and open/close the annular duct (20) at the bottom, said first shutter (24) being configured to be inserted inside the bottle during a

condition of use of the filling unit (1) .

3. The unit according to claim 1 or 2, **characterized in that** said second shutter is positioned at the lower end of said inner tube and configured to be introduced into said bottle.

4. The unit according to any one of the preceding claims, wherein the first shutter (24) is fixed to the inner tube (18) and wherein the assembly formed by the inner tube (18) and the first shutter (24) is vertically movable between an opening position, wherein it opens the annular duct (20) to maximum to allow the liquid contained in the tank (9) to flow downwards and fill the bottle, and a closing position, wherein it occludes the annular duct (20) at the bottom, thus preventing outflow of the liquid from the annular duct (20) .

5. The unit according to any one of the preceding claims, **characterized in that** it further comprises a first linear actuator (32), adapted to control the vertical movement of the first shutter (24), a movement head (34) integrally movable with the inner tube (18) along the axis of the latter, and a second linear actuator (36), axially interposed between the first linear actuator (32) and the movement head (34), said second linear actuator (36) being movable between an inactive position in which it is at a maximum distance D_0 from a lower face of the movement head (34), and an active position in which it engages said lower face of the movement head (34), the maximum stroke M_0 of said second linear actuator (36) between the active and inactive positions being comprised between the stroke So of the movement head (34) between said opening and closing positions of the first shutter (24) and said maximum distance D_0.

6. The unit according to claim 5, wherein the filling device (10) comprises at least one support column (38), fixed relative to the body (12) and extending along an axis parallel to and not coinciding with the axis of said body (12), said support column (38) comprising two abutments (38a, 38b) against which the movement head (34) in the opening position of the first shutter (24) and the second linear actuator (36) in the active position abut respectively.

7. The unit according to claim 5 or 6, wherein said lower face of the movement head (34) is carried by a ring nut (35), coupled to the movement head (34) and axially adjustable so as to vary said maximum distance D_0.

8. The unit according to any one of the preceding claims, **characterized in that** it comprises a third linear actuator (44), adapted to control the vertical movement of the second shutter (42), the first linear actuator (24) and the third linear actuator (44) being fitted in series with each other.

9. A method for filling a bottle with a food liquid using a filling unit as claimed in claim 1; the method comprising the steps of inserting the inner tube inside the bottle, feeding the liquid into the bottle by opening said annular duct and either filling by level or filling by volume by controlling the second or third operating means according to a liquid delivery signal received from the flow meter and proportional to the volume of liquid delivered through the annular channel.

10. The method according to claim 9, **characterized in that** the filling by level is carried out by defining a desired liquid level in the bottle, measuring the volume of liquid delivered by means of the flow meter, comparing the volume delivered with the volume of liquid envisaged to reach the desired level and obstructing the rise of the liquid in the inner tube at the moment when the volume of liquid delivered is equal to the volume of liquid envisaged.

11. The method according to claim 10, **characterized in that** the step of obstructing the rise of the liquid inside the inner tube comprises the step of bringing the first or the second shutter to an occlusion position thereof in response to a delivery signal corresponding to the delivery of a volume of liquid near or equal to the volume of liquid envisaged to obtain the desired liquid level.

12. The method according to any one of the claims from 9 to 11, **characterized in that** the filling by level comprises the further step of opening and closing the annular duct by means of said first operating means to deliver the volume of liquid necessary to reach the desired level in the bottle, verifying the correct operation of said operating means and said shutters by comparing, instantly or at the end of the delivery, the volume of liquid measured by the flow meter with the volume envisaged to reach the desired level, and generating a failure or alarm signal if there is a difference between the two volumes.

13. The method according to claim 12, **characterized in that** the control of said operating means and of said actuators is carried out after filling by level each of the bottles.

14. The method according to any one of the claims from 9 to 13, **characterized in that** the filling by level comprises the steps of commanding said first actuator means to close so as to choke the passage section of said annular duct when the volume of liquid measured by said flow meter is near the volume of liquid envisaged to reach the desired level or near the de-

sired volume during the filling by volume.

15. The method according to claim 9, **characterized in that** said step of filling by volume comprises the step of determining the level of the liquid inside the bottle after the flow meter has detected that a volume of liquid equal to the desired volume of liquid has been delivered into the bottle, arranging the outlet of the annular duct and the inlet of the inner tube above the determined liquid level and vertically adjusting the distance of the outlet of the annular duct in the space comprised between the determined liquid level and the upper end of the bottle so as to cause the fluid threads of the liquid supplied to the bottle to adhere to the inner surface of the bottle whatever the geometric and dimensional characteristics of said inner surface.

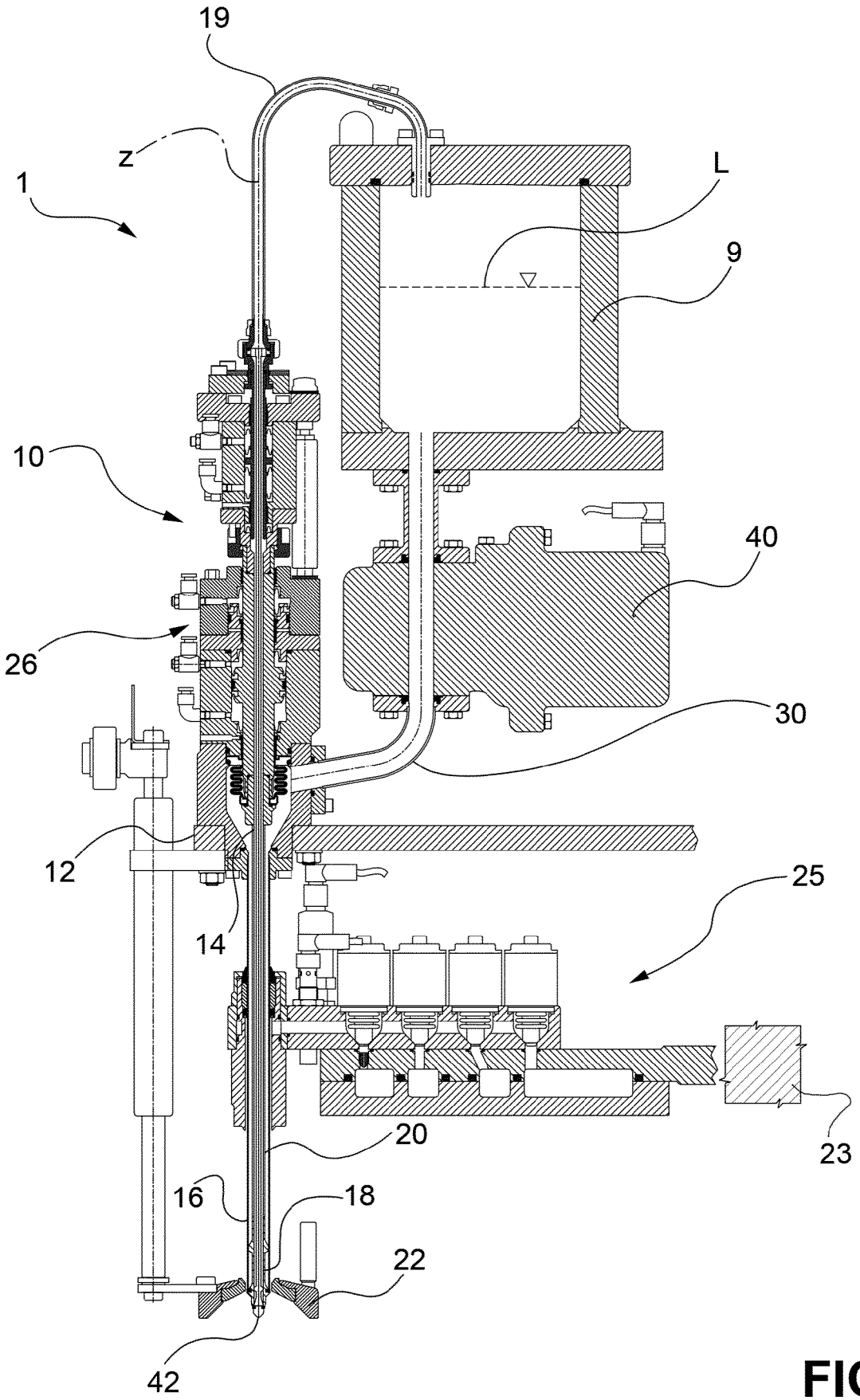


FIG.1

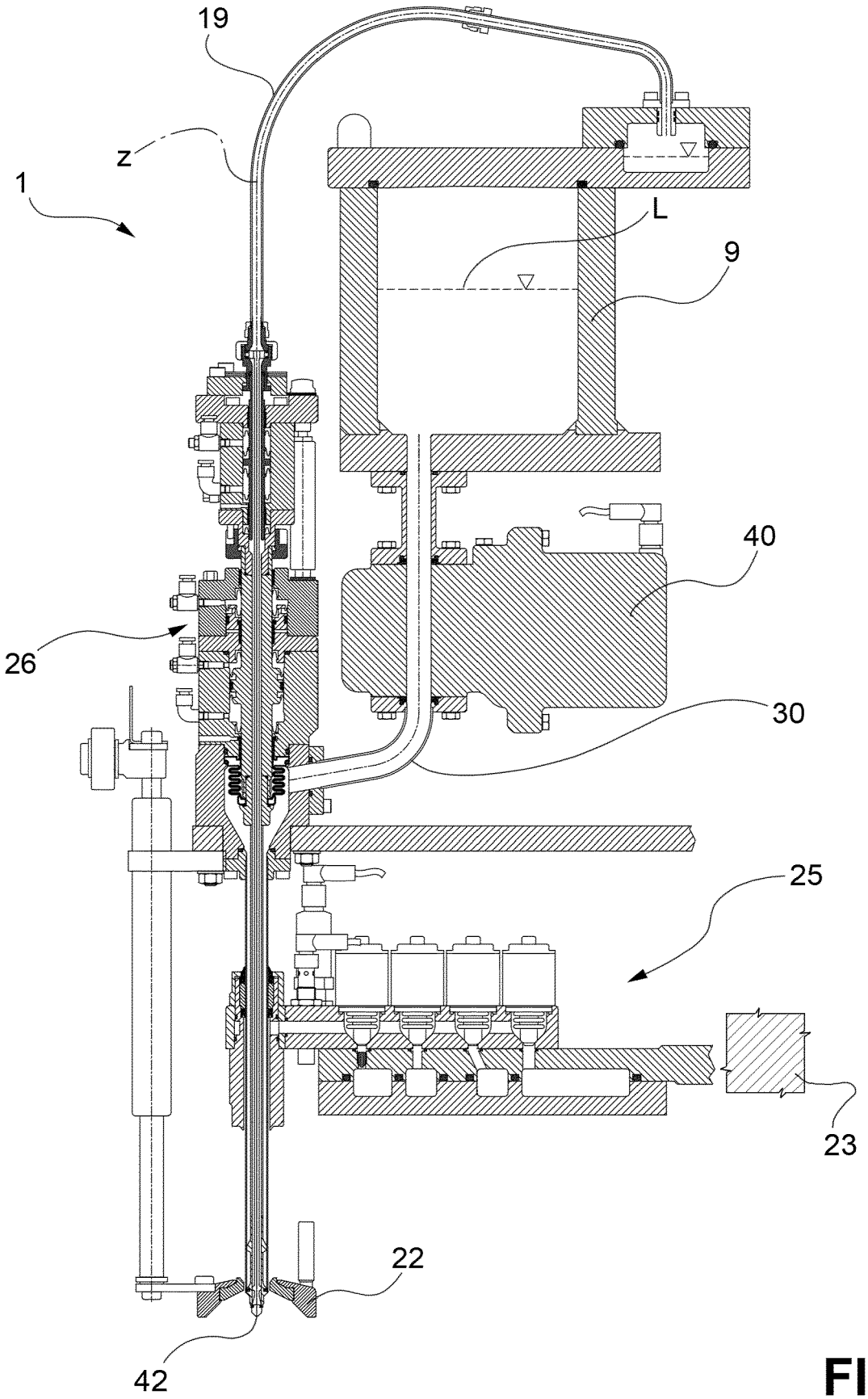


FIG.2

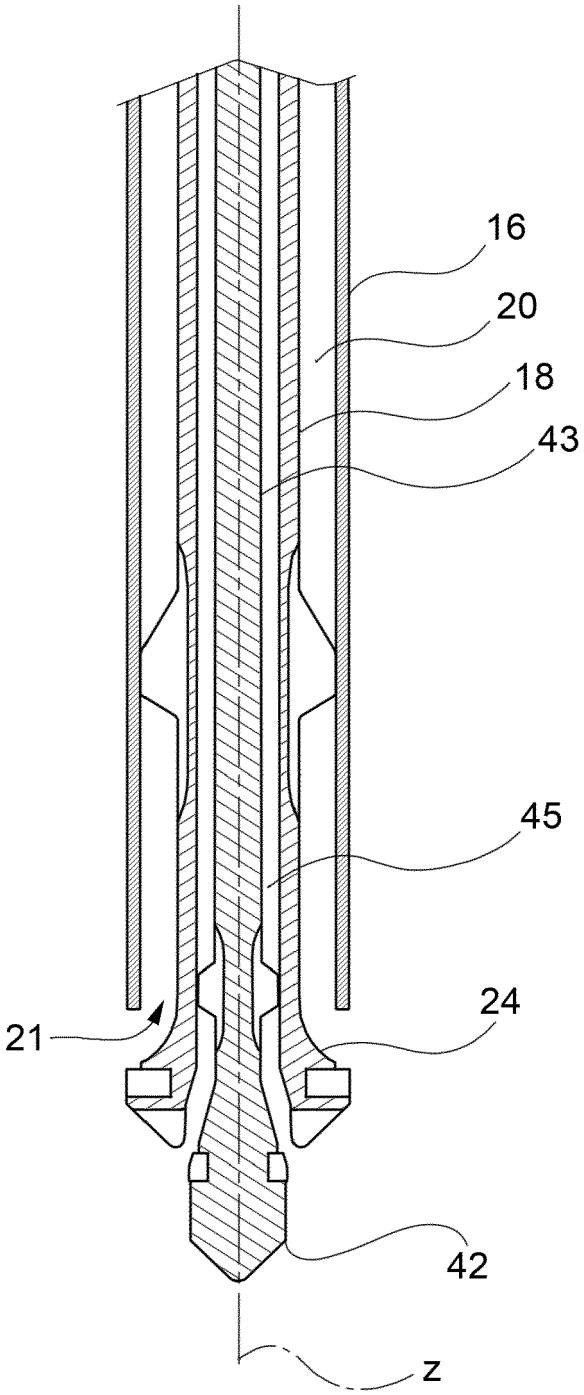


FIG.3

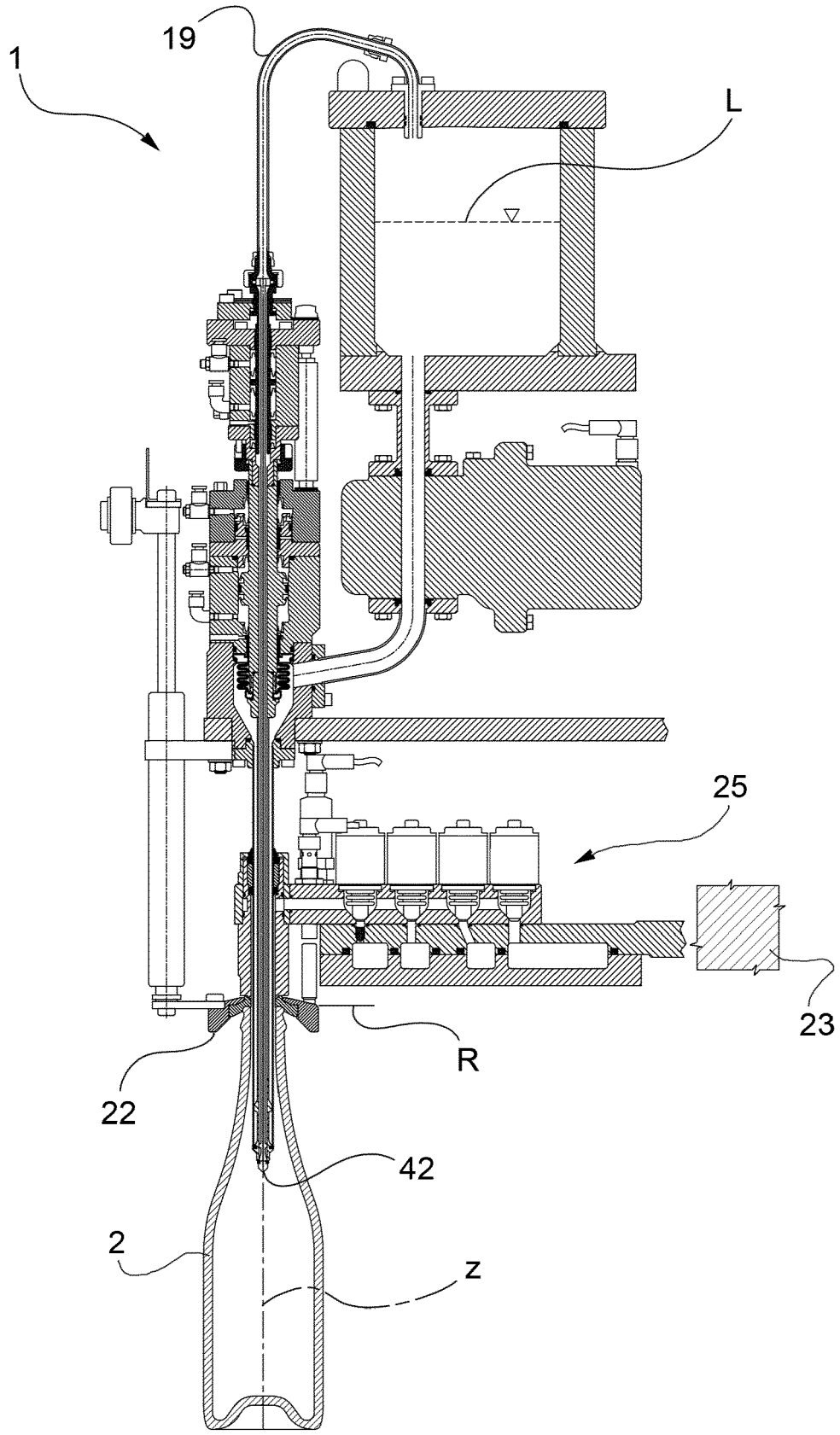


FIG.4

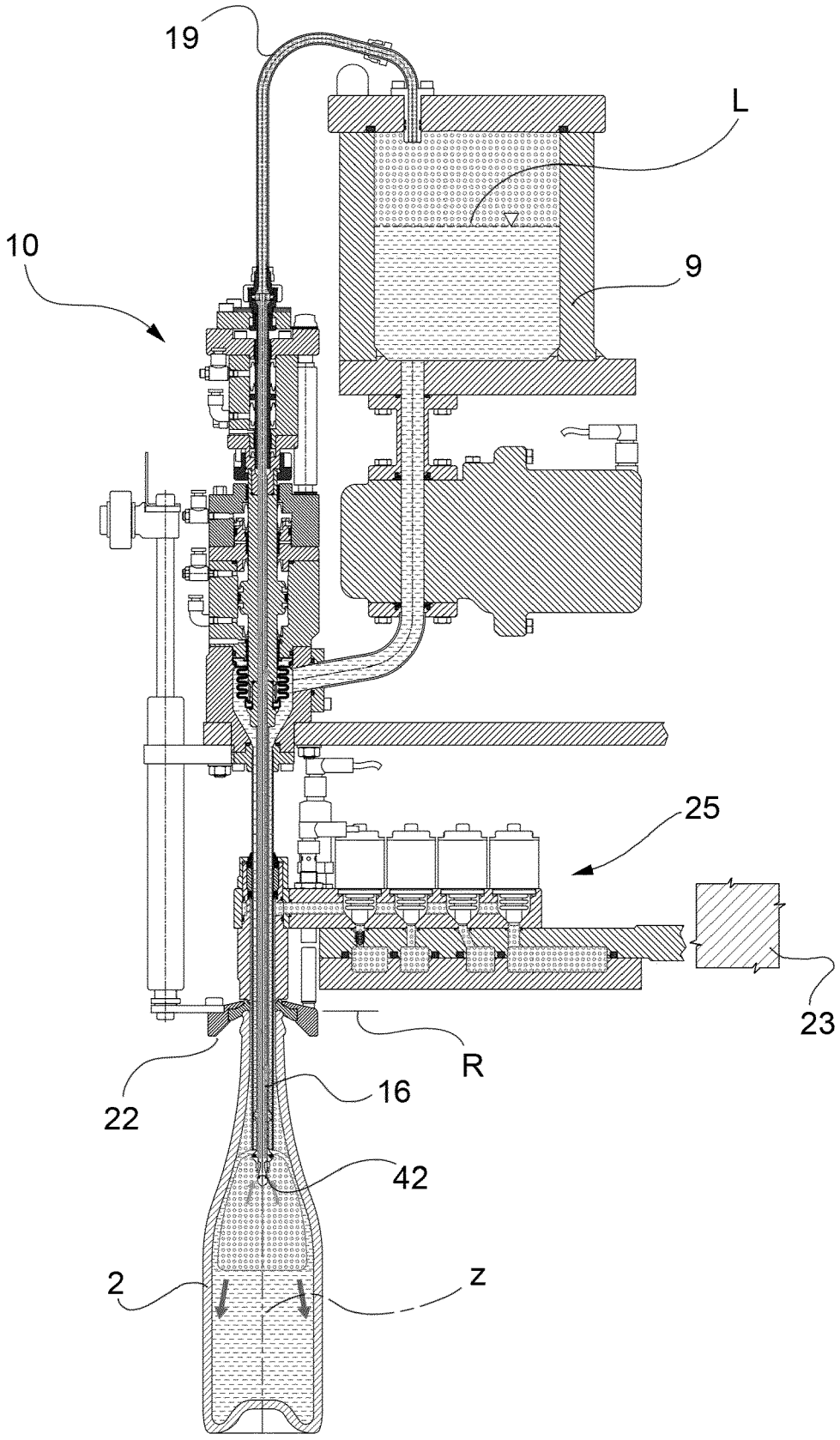


FIG.5

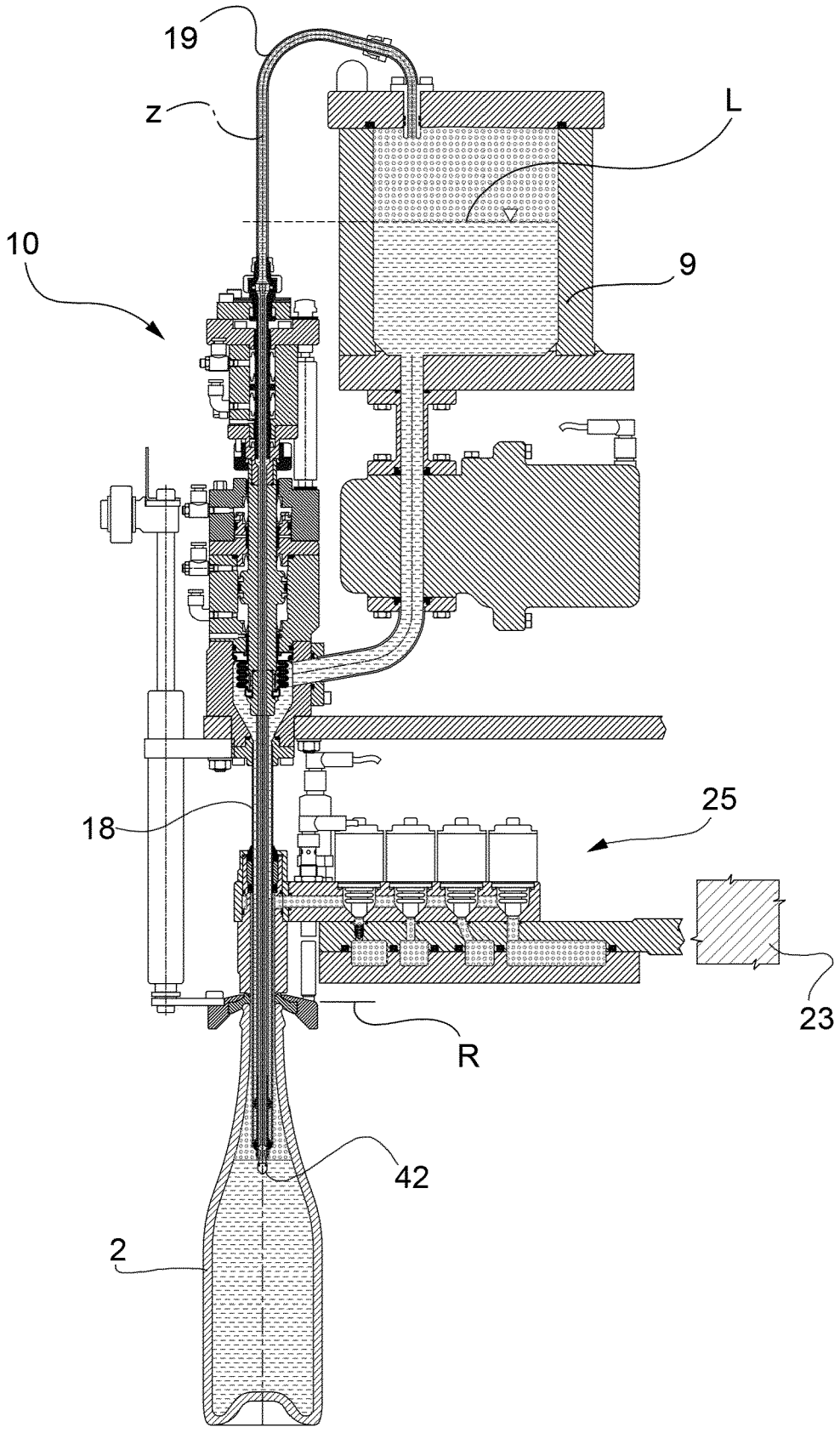
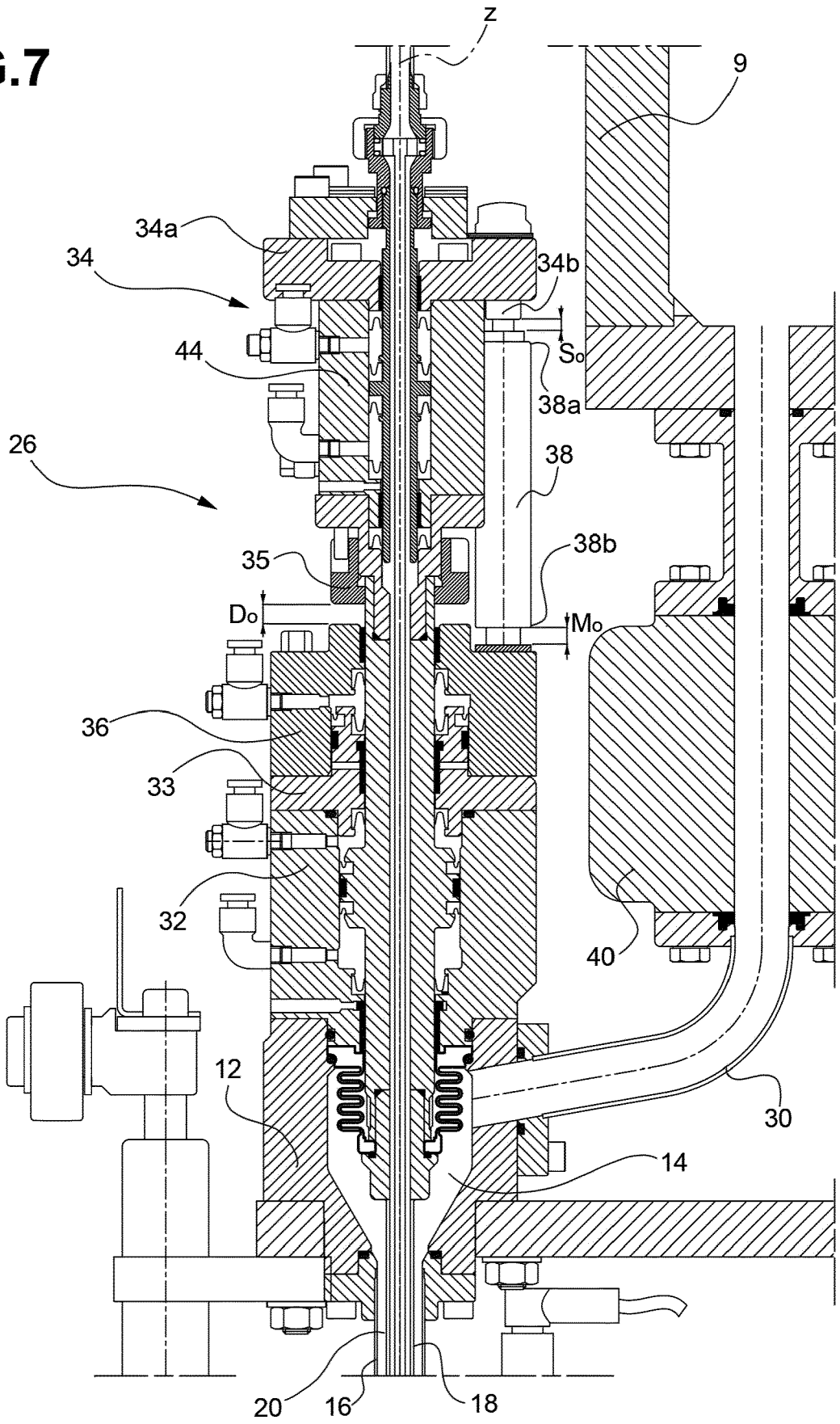


FIG.6

FIG.7


z
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34a
34
34b
44
So
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FIG.8

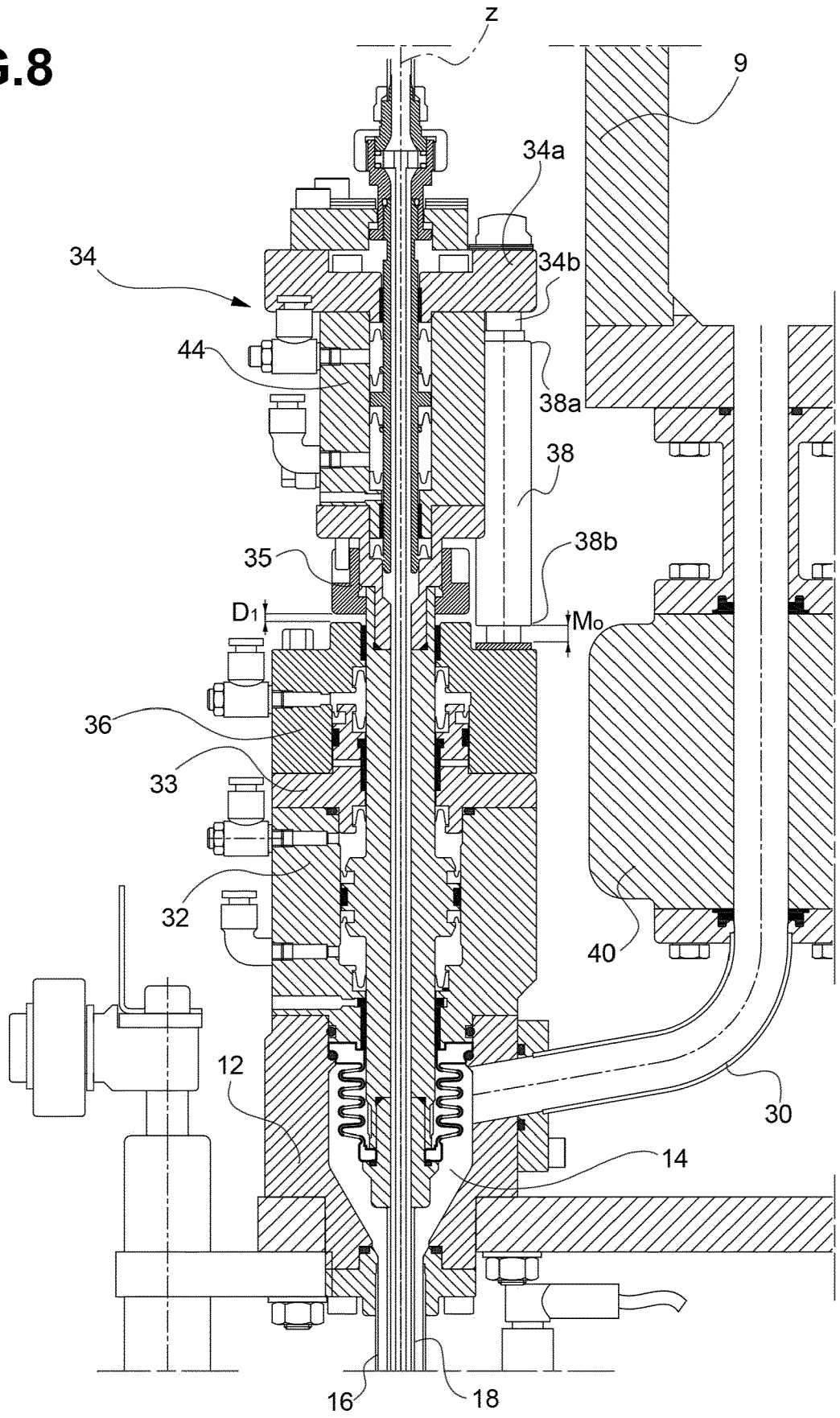
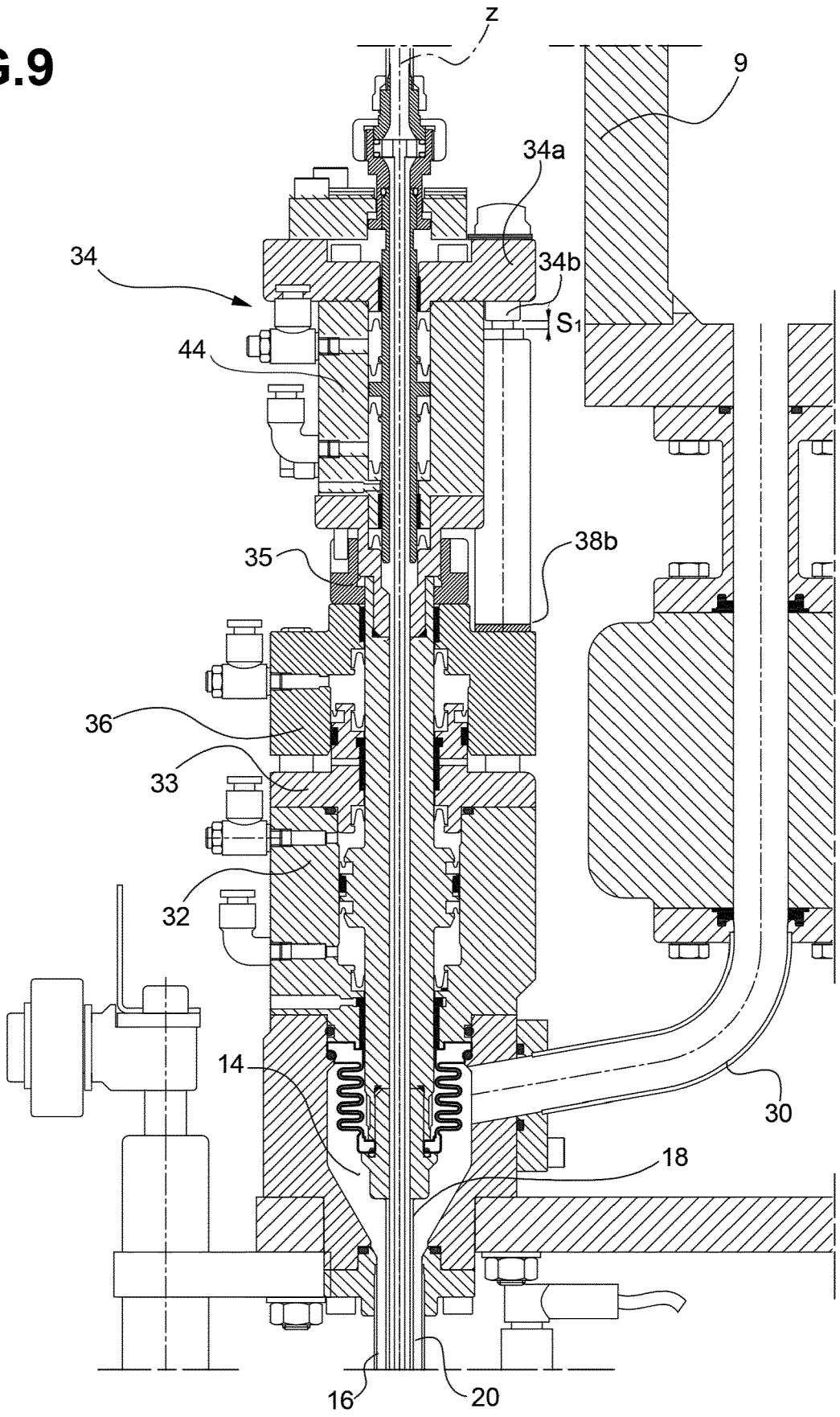


FIG.9



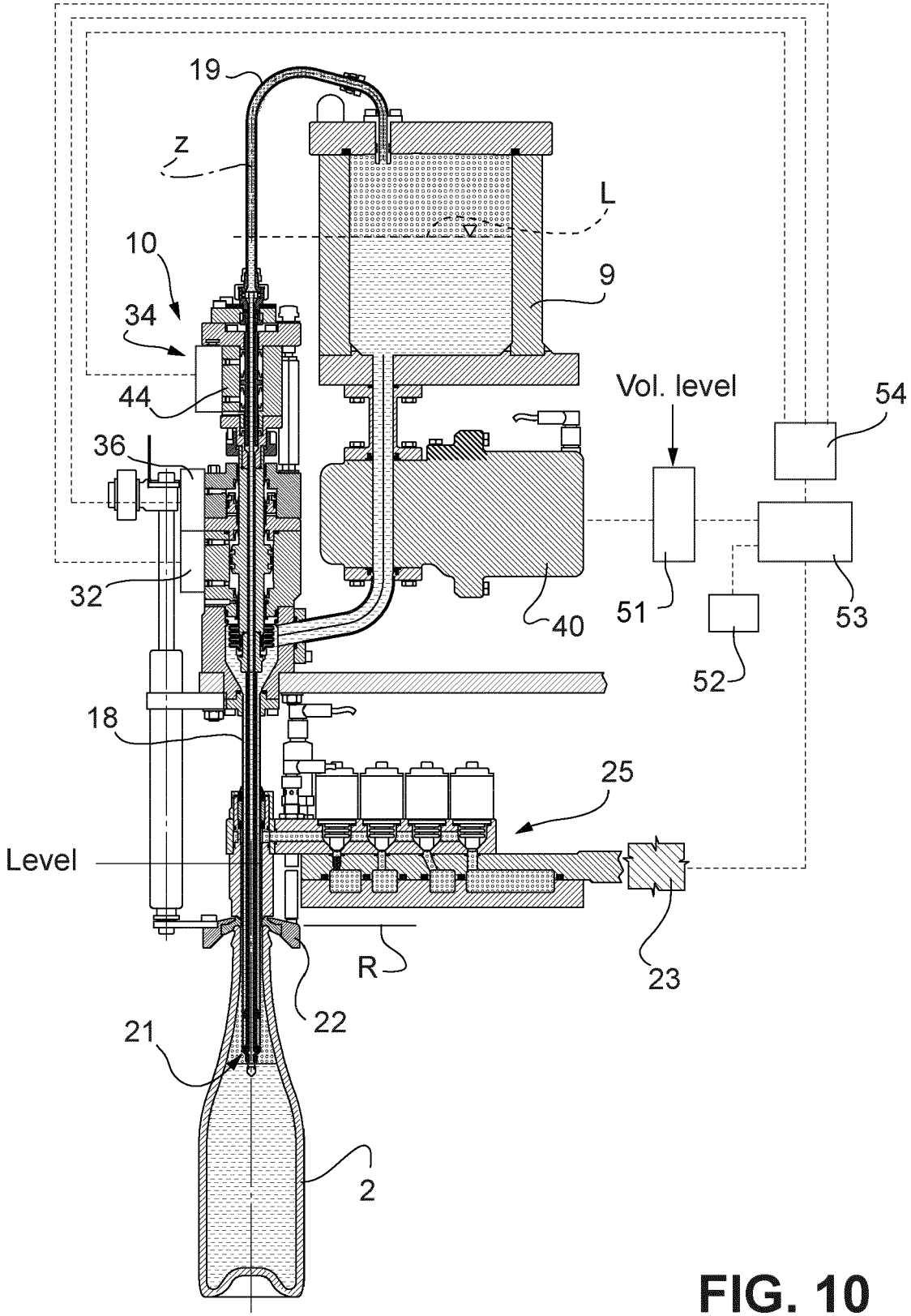

19
z
L
10
9
34
44
Vol. level
54
36
32
40
51
53
52
18
25
Level
R
23
22
21
2

FIG. 10

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EUROPEAN SEARCH REPORT

Application Number
EP 22 17 9374

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			B67C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	12 October 2022	Pardo Torre, Ignacio

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