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(54) **Filling machine, in particular for filling a container with a pasteurized liquid**

(57) A filling machine (1), in particular for filling a container (2) with a pasteurized liquid, has a gas line (37), a liquid supply line (7) adapted to be connected to a liquid tank (8), and at least one filling device (15), which is provided with an inlet communicating with the liquid supply line (7), with a lower outlet and with a gas port communicating with the gas line (37); the filling machine also has a differential pressure sensor (51) connected to the gas line (37) and to the liquid supply line (7) to determine a feedback value defined by the pressure difference be-

tween such lines; the gas line (37) permanently communicates with a gas tank (41), which is separated from the liquid supply line (7) and is connected to a pressurized gas source and to a discharge opening by means of respective valves (44,48); these valves (44,48) are controlled by an electronic control unit to bring the pressure difference between the liquid supply line (7) and the gas line (37) to a set-point (S) in response to the feedback value.

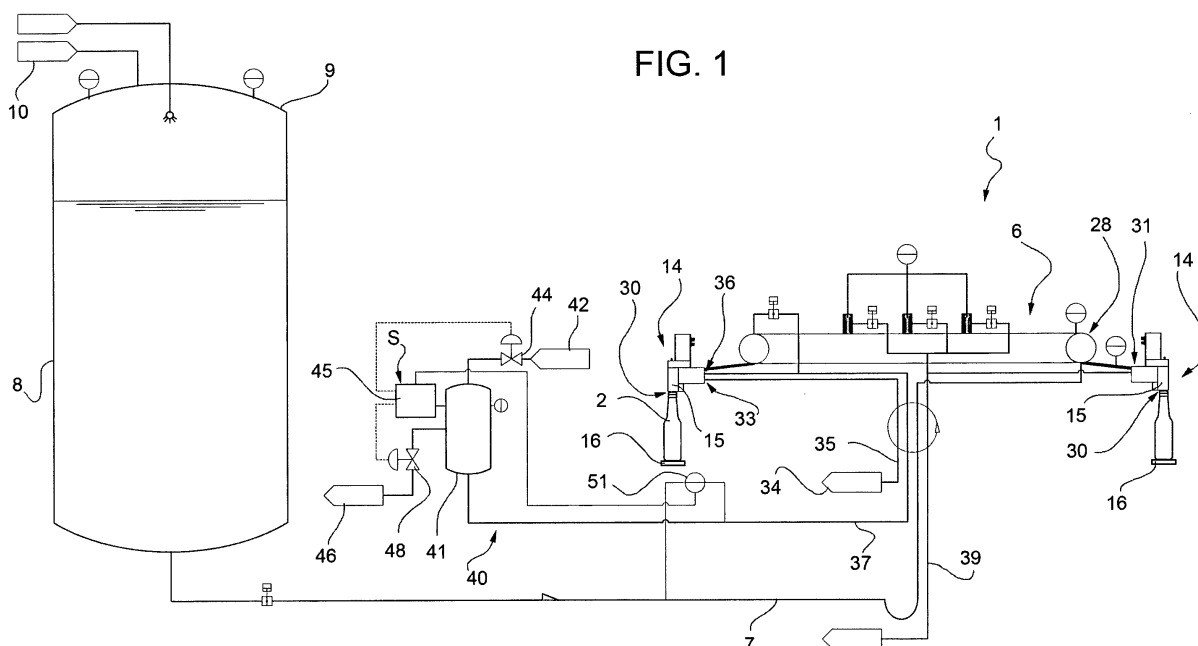


FIG. 1

Description

TECHNICAL FIELD

[0001] The present invention relates to a filling machine, in particular for filling a container with a pasteurized liquid.

BACKGROUND ART

[0002] As it is generally known, filling machines typically comprise a filling station, to which empty containers are fed and which supplies, at its output, containers filled with a liquid.

[0003] The filling station essentially has a carousel conveyor, rotating about a vertical rotation axis and carrying a plurality of filling devices, which are radially spaced apart from the rotation axis of the conveyor. More specifically, the conveyor comprises a plurality of container supports for positioning the mouths of the containers beneath the respective filling devices, and for moving the containers along with the respective filling devices along an arc-shaped path about the rotation axis.

[0004] Each filling device substantially comprises a filling chamber and a filling head movable along a direction parallel to the rotation axis of the conveyor, so as to move from and towards the respective container mouth. Each filling device further comprises a stopper movable inside the filling chamber between a closed position, to cut off the liquid flow to the mouth of the respective container, and an open position, to put the filling chamber in communication with such a mouth, thereby enabling the liquid to flow into the container.

[0005] The filling machine further comprises a supply system connecting the filling chambers to a main tank, in which liquid for filling the containers is stored and pressurized. In some embodiments, especially for pasteurized liquids, the supply system comprises: a supply line, connecting the filling station to the main tank; a buffer tank, having a bottom portion communicating with the supply line and a top portion which contains a gas, i.e. carbon dioxide, and communicates with a gas line to pressurize the liquid of the bottom portion; and a pump arranged along the supply line between the buffer tank and the filling station and controlled to supply the liquid from the bottom portion of the buffer tank to the filling station, without recirculation of the liquid to the main tank.

[0006] Before being filled with a carbonated liquid, each container is subjected to some preliminary steps, in particular to a first evacuation step, in which air is sucked from the container by means of a vacuum system; to a flushing step, in which carbon dioxide is supplied into the container and mixed with the remaining air; to a second evacuation step, in which the mix of residual air and carbon dioxide is sucked by means of the vacuum system; and a pressurization step, in which carbon dioxide is supplied from the above mentioned gas line into the container to pressurize the container to a given pres-

sure.

[0007] After pressurization, the stopper is moved to the open position and the container is filled. In particular, filling may comprise a fast-rate first filling step and, afterwards, a slow-rate second filling step. To the purpose of controlling the start and/or the end of the first and second filling steps, each filling device further comprises a sensing device, in particular a probe, for detecting the level of the liquid inside the container.

[0008] After having filled the container with the liquid, the carbon dioxide at the container neck is depressurized, so that the pressure above the liquid level equals atmospheric pressure.

[0009] During the filling step, carbon dioxide progressively flows out of each container towards the gas line and therefore towards the upper portion of the buffer tank. In the meantime, the pump is controlled by a control unit in order to adjust the pressure difference between the pressure of the pumped liquid and the pressure in the gas line, in relation to a set-point that have been set according to the process and/or to the kind of liquid.

[0010] Filling machines of the above kind are rather unsatisfactory, especially because of the cost and the complexity of the supply system that connects the filling station to the main tank. In particular, the above mentioned supply system requires the installation of a relatively big buffer tank and of the controlled pump, with the correspondent valves and connections.

[0011] Moreover, the gas used for pressurizing the containers before filling is not pure, as it comes from a storing space, i.e. the upper portion of the buffer tank, where the gas is in contact with the liquid.

DISCLOSURE OF INVENTION

[0012] It is an object of the present invention to provide a filling machine which allows to overcome the above drawbacks in a straightforward and low-cost manner and, in particular, allows to connect the filling station directly to the main tank without buffer tanks, in order to use the static head of the main tank as a pressure source to supply the liquid towards the filling station, without impairing the control of the whole filling process. In particular, the control of the filling process should be carried out promptly in response to changes of the static head of the main tank.

[0013] This object is achieved by a filling machine, in particular for filling a container with a pasteurized liquid, as defined in claim 1.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] A non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

- Figure 1 is a schematic cross-section partially showing a filling machine, in particular for filling a container

with a pasteurized liquid, according to the present invention; and

- Figure 2 is a perspective view showing details of the machine of Figure 1.

BEST MODE FOR CARRYING OUT THE INVENTION

[0015] In Figures 1 and 2, reference number 1 indicates, as a whole, a machine (partially and schematically shown) for filling containers 2 with liquid.

[0016] As shown in figure 2, each container 2 is defined, by way of example, by a glass or plastic bottle, has a substantially vertical axis 3, is bounded at the bottom by a bottom wall 4 substantially perpendicular to axis 3, and has a top neck 5 substantially coaxial with axis 3.

[0017] With reference to figure 1, filling machine 1 comprises a filling station or filling assembly 6; and a liquid supply line 7, which puts the filling station 6 into communication with a liquid tank 8, without any buffer tank and without any pump between liquid tank 8 and filling station 6.

[0018] Liquid tank 8 contains the liquid the containers 2 have to be filled with, and comprises an upper portion 9 connected to a pressurized gas source 10, in particular a carbon dioxide source, to pressurize the liquid. In particular, the liquid is defined by beer obtained by means of a pasteurization process. In general, liquid tank 8 is not part of the machine 1 and is connected to the supply line 7 by means of pipe fittings (not shown). Supply line 7 may be provided with a shut-off valve to possibly close the liquid flow passage towards the filling station 6.

[0019] Filling station 6 has at least one supporting and filling unit 14, which comprises a filling device 15 and a support 16, located beneath device 15 and designed to support the bottom wall 4 of a respective container 2. Unit 14 further comprises an actuator (not shown) to move one of device 15 and support 16 along a vertical axis, in relation to the other one of device 15 and support 16, in order to couple/uncouple device 15 to the upper mouth of the container 2 that has been received on the support 16.

[0020] As shown in figure 2, filling station 6 has a plurality of the above-mentioned units 14, which are carried by a conveyor 19 (partially shown), forming part of the filling machine 1, and are transferred along a path, while the containers 2 are being filled with the liquid supplied by the respective devices 15. Conveyor 19 is preferably defined by a carousel conveyor, mounted on a base structure to rotate continuously about a substantially vertical axis 20. Conveyor 19 receives a succession of empty containers 2 from an input wheel 21, which cooperates with the conveyor 19 at a transfer station 22 and is mounted to rotate about an axis parallel to axis 20. Conveyor 19 releases a succession of filled containers 2 to an output wheel 24, which cooperates with the conveyor 19 at a transfer station 25 and is mounted to rotate about an axis also parallel to axis 20. The rotations of the input wheel 21 and the output wheel 24 are continuous and

synchronized with the rotation of the carousel conveyor 19.

[0021] Preferably, units 14 are equally spaced from each other about axis 20 and are equally spaced from axis 20. Therefore, units 14 are moved by conveyor 19 along a circular path, through stations 22 and 25, and transfer the respective containers 2 from station 22 to station 25 along an arc-shaped path.

[0022] With reference to figure 1, filling station 6 has an annular chamber 28, which is arranged around axis 20 and is connected to an end of the supply line 7 and to all the devices 15.

[0023] Each device 15 comprises a fastening body (not shown), coupled to conveyor 19; an inner chamber (not shown) having a lower outlet 30; and an inlet 31, which is in communication with the annular chamber 28 to receive liquid that has to be supplied into the mouth of the respective container 2 through outlet 30. Each device 15 further comprises a stopper device (not shown) controlled for opening/closing the outlet 30 so as to allow/shut-off liquid flow to the respective container mouth.

[0024] Devices 15 preferably comprise respective suction ports 33, which are connected to a vacuum source 34 by means of a pneumatic line 35, to remove air from the containers 2 before filling the latter. Besides, devices 15 comprise respective gas ports 36, which permanently communicate with a gas line 37. Each gas port 36 defines either a gas inlet, to pressurize the respective container 2 with a gas, in particular with carbon dioxide, supplied by gas line 37 before filling the container 2 with the liquid; or a gas outlet, to let the gas flow out of the container 2 into gas line 37 when the container 2 is being filled. Therefore, line 37 is the only gas conduit for supplying gas to, and receiving gas from, the devices 15.

[0025] Moreover, filling machine 1 comprises a known cleaning system 39 connected to the liquid tank 8 and to the filling station 6.

[0026] Gas line 37 may be provided with a shut-off valve (not shown) and defines part of a gas system 40, further comprising a gas tank or gas accumulator 41, which is connected to an end of gas line 37 and is external to the filling station 6. Gas system 40 is separate and independent from the upper portion 9 of the liquid tank 8, i.e. there is no fluid communication between upper portion 9 and gas system 40.

[0027] Gas tank 41 can be provided with a pressure sensor, level sensors, a water drainage device, a safety valve, filters, etc..., which are not shown in detail.

[0028] Gas tank 41 is connected to a pressurized gas source 42, similar to source 10, by means of an adjustment valve 44, which is automatically controlled by an electronic control unit 45 to open/close gas flow passage between source 42 and line 37. When valve 44 is opened to allow gas flow, source 42 supplies gas into the gas tank 41 and therefore pressure in the whole gas system 40 increases.

[0029] Gas tank 41 is also connected to a discharge opening 46 by means of an adjustment valve 48, which

is also automatically controlled by unit 45 to open/close gas flow passage between line 37 and the external environment. When valve 48 is opened to allow gas flow, gas is discharged from gas tank 41 into the atmosphere and therefore pressure in the whole gas system 40 decreases. Preferably, opening 46 is provided with a silencer (not shown), to reduce noise of gas flowing out of gas tank 41. Preferably, valves 44,48 are connected to the gas tank 41 by means of pipes which are distinct from the gas line 37, or they are directly mounted on the gas tank 41.

[0030] Before being filled with the liquid, each container 2 is subjected to some preliminary steps, in particular to a first evacuation step, in which air is sucked from the container 2 by means of the vacuum source 34; to a flushing step, in which gas is supplied into the container 2 from the gas port 36 and mixed with the remaining air; to a second evacuation step, in which the mix of residual air and gas is sucked by means of the vacuum source 34; and a pressurization step, in which gas is supplied from the gas port 36 into the container 2 to pressurize the container 2.

[0031] After pressurization, the stopper device opens and the container 2 is filled. In particular, filling may comprise a fast-rate first filling step and, afterwards, a slow-rate second filling step. To the purpose of controlling the start and/or the end of the first and second filling steps, each filling device further comprises a sensing device, in particular a probe, for detecting the level of the liquid inside the container 2.

[0032] After having filled the container 2 with the liquid, the gas still present at the neck 5 is depressurized, so that the pressure above the liquid equals atmospheric pressure.

[0033] During the filling steps, gas flows out of the containers 2 towards the gas line 37 and therefore towards the gas tank 41. Therefore, during filling, gas counterpressure in containers 2 is defined by the pressure in gas line 37. In the meantime, in line 7 the liquid supply pressure is solely defined by the static head in the liquid tank 8.

[0034] Unit 45 has a controller that controls opening and closing of valves 44 and 48 as a function of a feedback value defined by the difference in pressure between the supply line 7 and the gas line 37. Preferably, this feedback value is detected by a differential pressure sensor 51, which receives pressure fluid signals from both lines 7 and 37 and transmits an electric signal, correspondent to the detected pressure difference, to unit 45. As an alternative (not shown), the feedback value can be calculated as difference between two pressure values detected by respective pressure sensors arranged along lines 7 and 37. Unit 45 compares the feedback value with a set-point S, defined by a single value or a range, and controls valves 44 and 48 to bring the pressure difference between lines 7 and 37 to the set-point S. Set-point S can result from data stored in a memory of unit 45 or can be set by means of a remote interface. In particular, set-point S is variable as a function of the kind of filling proc-

ess and/or as a function of the kind of liquid. Preferably, the controller of unit 45 is a PID controller.

[0035] As mentioned above, according to the present invention the pressure in gas system 40 is adjusted by means of the valves 44,48 and the control carried out by unit 45, in order to keep the pressure difference between lines 7 and 37 at a level defined by the set-point S. In particular, the static head progressively decreases, as the liquid level lowers in the liquid tank 8, but the control carried out by unit 45 on valve 48 lowers in corresponding manner the pressure in gas tank 41 and, therefore, in line 37. In other words, unit 45 controls the opening of valve 48 so as to discharge gas from the gas tank 41 when the feedback value becomes lower than the set-point S.

[0036] In the meantime, unit 45 can control the opening of valve 44 to restore pressure in gas system 40 if the feedback value becomes higher than the set-point S.

[0037] In this way, the static head of the liquid tank 8 does not influence the filling process, as the pressure difference between the pressure of the supplied liquid and the counterpressure in containers 2 is always kept at the desired level to satisfy the requirements of the filling process. In the meantime, line 7 is connected directly to the liquid tank 8 without any buffer tank and without any pump between the filling station 6 and the liquid tank 8. In other words, the filling head, i.e. the pressure difference between lines 7 and 37, is no more controlled by the pressure set by a supply pump, but it is controlled by the pressure of the relatively small gas tank 41, in turn controlled by the two valves 44,48.

[0038] By way of example, gas tank 41 has a volume between about 50 and 100 dm³, i.e. a volume which is smaller and therefore less bulky than the usual buffer tanks provided in the prior art. Below a volume of about 50 dm³ the process would not be controllable in stable manner, because of limits in the response time of instruments and valves currently available on the market (in the future, it would be probably possible to reduce such minimum volume, by using more responsive sensors and valves). Above a volume of about 100 dm³, the control of the filling head would have too high response time in relation to the changes of the static head in the liquid tank 8.

[0039] Line 37 comprises a pipe that connects the filling station 6 to the gas tank 41 and should have a length of less than about 10 meters. Furthermore, it is advisable to sense the gas pressure in a point near to the devices 15.

[0040] Thanks to these last features, during the transitory phases of the filling process it is possible to reach the desired counterpressure in the containers 2 and therefore the desired set-point S with a maximum error of about 20 mbar. In normal filling conditions, the maximum error is further reduced.

[0041] In the meantime, the control of the system maintains the correct filling head with a response time of about 300 ms in relation to changes of the static head of the

liquid tank 8.

[0042] Moreover, the bottled liquid is more stable, because it is not shook by pumps before arriving at the devices 15.

[0043] It is evident from the above described features that it is possible to have a simpler and cheaper solution, with respect to the prior art solutions, as the supply line 7 does not need a buffer tank and/or pumps, with the correspondent connections.

[0044] This solution is so simple that it is possible to easily adapt previously installed machines and/or the design of new machines to provide the new features.

[0045] Furthermore, controlling the pressure difference between lines 7 and 37 requires less power consumption, because of the absence of supply pumps along line 7.

[0046] Thanks to the absence of the buffer tank and pumps, also maintenance and cleaning require less time and costs. In particular, for cleaning the filling machine 1, chemicals and energy consumption is reduced thanks to the volume reduction of the liquid supply system.

[0047] Furthermore, gas stored in gas tank 41 is not contaminated, as it is completely separated from air and from the liquid that is stored in liquid tank 8 and is supplied by line 7.

[0048] Clearly, changes may be made to the filling machine 1 as described and illustrated herein, however without departing from the scope of protection as defined in the accompanying claims.

[0049] In particular, valves 44 and 48 could be integrated in a single valve controlled by unit 45 to seal gas tank 41 or to put gas tank 41 selectively in communication with the external environment or with a pressurized gas source; and/or valves 44,48 could be connected to gas line 37 near gas tank 41, instead of being connected directly to gas tank 41; and/or pressure of line 37 could be sensed in a different point between the device 15 and the gas tank 41 (by instance, it could be sensed at the conveyor 19 or at the gas tank 41).

[0050] Finally, filling machine 1 can be advantageously used also for carbonated soft drinks, and not only for beer.

Claims

1. A filling machine (1), in particular for filling a container with a pasteurized liquid, comprising:

- a gas line (37);
- a liquid supply line (7), adapted to be connected to a liquid tank (8);
- at least one filling device (15) comprising:

- a) an inlet, communicating with said liquid supply line (7) to receive a liquid stored in said liquid tank;
- b) a lower outlet, for supplying the liquid into

said container (2) during filling;

c) a gas port, communicating with said gas line (37) and defining a gas outlet for letting gas flow out of the container (2) towards said gas line (37) during filling;

- pressure sensor means (51) connected to said gas line (37) and to said liquid supply line (7) to determine a feedback value defined by the pressure difference between said liquid supply line (7) and said gas line (37);

- an electronic control unit configured to bring the pressure difference between said liquid supply line (7) and said gas line (37) to a set-point (S) in response to said feedback value;

characterized by further comprising:

- a gas tank (41), which permanently communicates with said gas line (37) and is separated from said liquid supply line (7);

- first valve means (44) to put said gas tank (41) in communication with a pressurized gas source; opening of said first valve means (44) being controlled by said electronic control unit to increase pressure inside said gas tank (41);

- second valve means (48) arranged between said gas tank (41) and a discharge opening; said electronic control unit being configured to open said second valve means (48) so as to discharge gas from said gas tank (41) when said feedback value becomes lower than said set-point (S).

2. Filling machine according to claim 1, **characterized in that** said electronic control unit is configured to open said first valve means (44) so as to pressurize said gas tank (41) when said feedback value becomes higher than said set-point (S).

3. Filling machine according to claim 1 or 2, **characterized in that** said gas tank (41) is external and spaced apart from said filling device (15).

4. Filling machine according to claim 3, **characterized by** comprising a filling station (6) having a conveyor (19) and a plurality of said filling devices (15) carried by said conveyor (19); said gas tank (41) being external and spaced apart from said filling station (6).

5. Filling machine according to claim 4, **characterized in that** said gas line (37) comprises a pipe connecting said gas tank (41) to said filling station (6) and having a length less than about 10 meters.

6. Filling machine according to anyone of the previous claims, **characterized in that** said pressure sensor means (51) are connected to said gas line (37) at a point located between said gas tank (41) and said filling device (15).

7. Filling machine according to anyone of the previous claims, **characterized in that** said gas port also defines a gas inlet, for pressurizing the container (2) with gas from said gas line (37) before filling.

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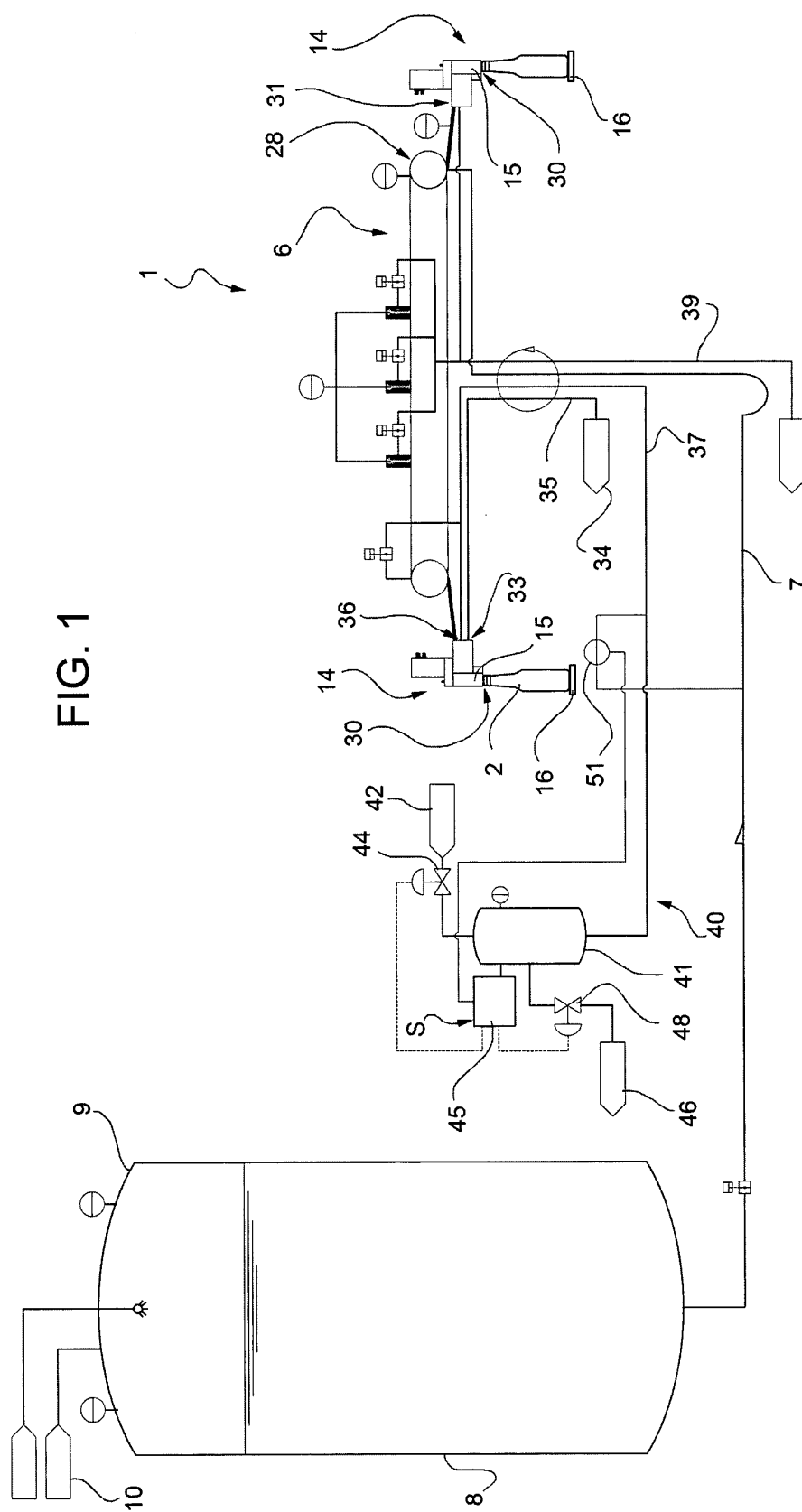
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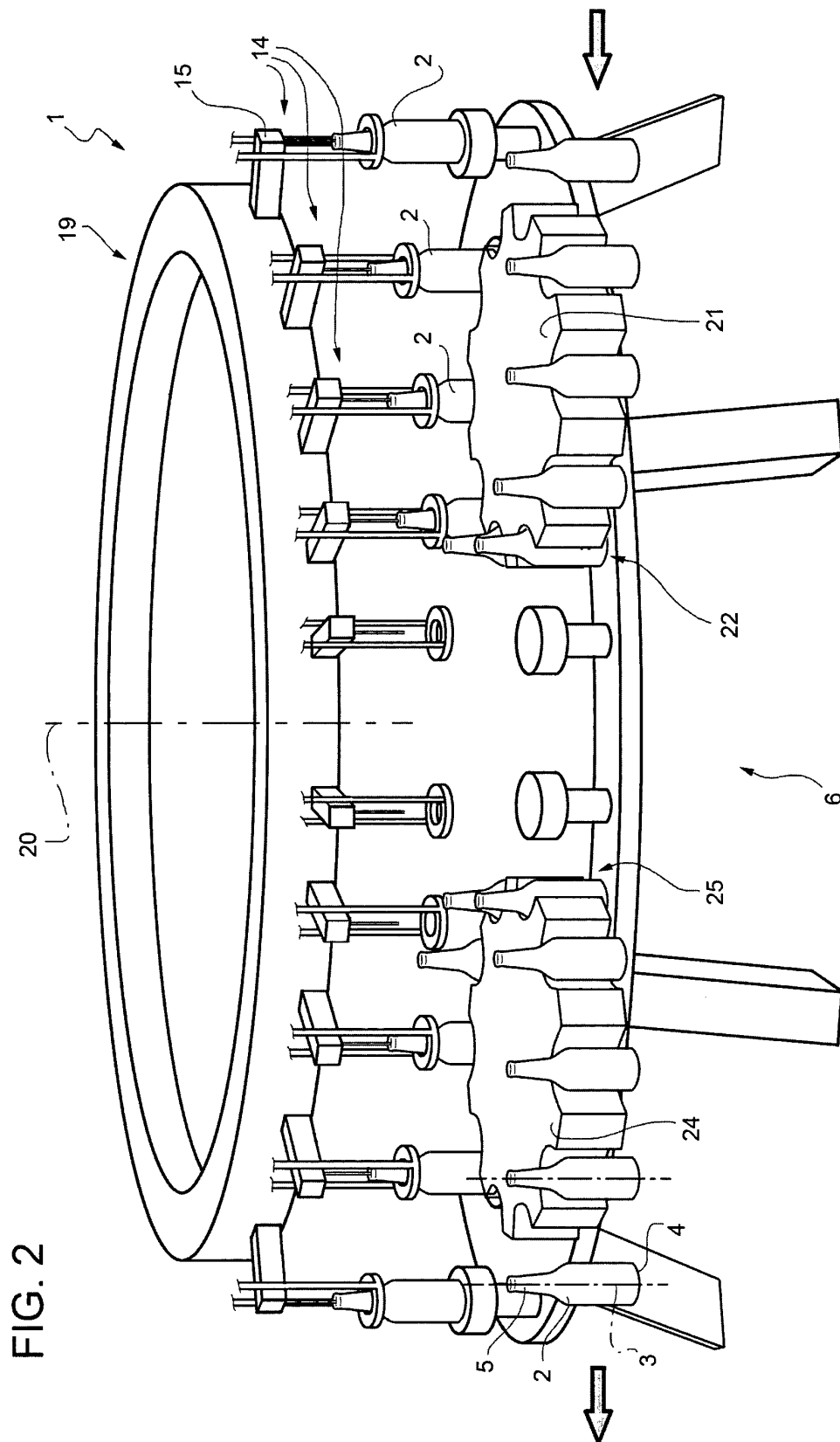
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EUROPEAN SEARCH REPORT

Application Number
EP 12 42 5204

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 2012/137317 A1 (MITSUBISHI HEAVY IND FOOD & PA [JP]; TANAKA YOSHIHARU [JP]; HAYASHI MA) 11 October 2012 (2012-10-11) * figure 10 * * abstract *	1,2	INV. B67C3/02 B67C3/06 B67C3/28
A	US 3 877 358 A (KARR FRED A) 15 April 1975 (1975-04-15) * figure 1 * * column 5, lines 21-55 *	1	
A	DE 44 02 980 C1 (KHS MASCH & ANLAGENBAU AG [DE]) 1 June 1995 (1995-06-01) * figure 1 *	1	
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			TECHNICAL FIELDS SEARCHED (IPC)
			B67C
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 6 May 2013	Examiner Pardo, Ignacio
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 12 42 5204

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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