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(54) A process and a device for headspace inertization of bottles filled with carbonated beverages

(57) The invention relates to a process for the inertization of the headspace of bottles (18) filled with carbonated beverages, in which a jet (17) of supercooled, liquid nitrogen is introduced into the headspace of the bottle, which is not filled with the beverage, in a metered and pressure-controlled fashion at a foaming means, the gas volume previously contained in the headspace being displaced from it by the resultant foaming, and a device for carrying out the process.

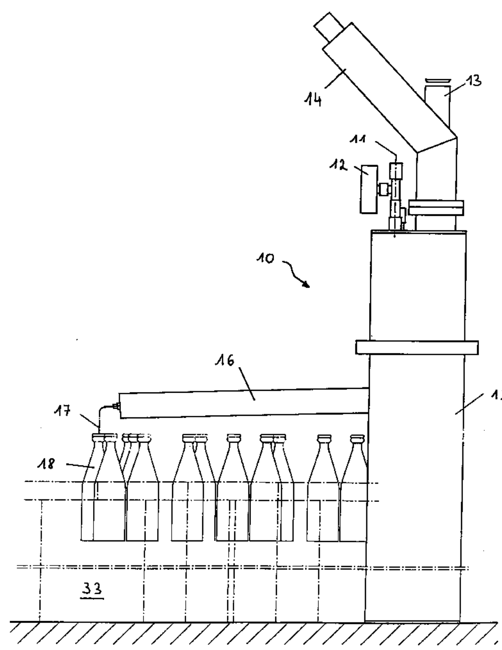

Fig. 1

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Description

The invention relates to a process for headspace inertization of bottles filled with carbonated beverages or beer, in which the beverage is foamed in the bottle after filling so that the gas volume previously contained in the headspace is displaced from it due to the arising foaming, and a device for carrying out this process.

In bottling plants, beer is filled into bottles in such a fashion that a residual gas volume remains in the headspace of the containers. This residual volume is at first filled with carbon dioxide in the case of beers containing CO_2. Since the bottles are exposed to ambient air during transfer from the bottling station to the sealing station, there is a risk of oxygen entering the headspace during this transfer, which promotes germ formation in such beverages and thus greatly reduces their storage stability.

For the aformentioned reason, beer is conventionally foamed during transfer from the bottling station to the sealing station by means of introducing a gaseous or liquid medium into the headspace onto the surface of the beer so that the resultant foam expels the gas volume, and thus also the oxygen that has entered, from the headspace. Thus, the oxygen content in the headspace can be reduced at the moment the bottle is sealed.

One example of such a foaming device is disclosed in German Utility Model No. 91 16 815 U1. A jet of liquid, here in particular water, is introduced into the headspace of the filled bottles at a pressure of 40 bar by means of the device described therein. The impulse of the water jet can be regulated.

It is in particular disadvantageous in such processes and devices according to the prior art that the beverage foam becomes relatively large-pored after the high-pressure water injection so that, despite larger overfoam volumes (2 to 5 ml/bottle), the average oxygen values that can be achieved in the headspace are no better than 0.018 to 0.1 mg per liter. The disadvantageous large overfoaming results in a high waste water pollutant load and thus substantial liquid waste disposal costs; also, the large overfoam volumes are equivalent to net beverage losses which, of course, are expensive per se.

A filling height correction for bottling liquids is described in DE-OS 4018660 A1. Here, an inert gas is used to build up an exactly defined pressure in the headspace of a bottle, by means of which an excess liquid volume is expelled from the bottle. The disadvantage is that the desired foaming does not take place here; the oxygen already contained in the headspace of the bottle remains there, and reduces the storage stability of the beverage.

The object of the present invention is to create a method and a device for headspace inertization of bottles filled with carbonated beverages or beer, which overcome the aforementioned disadvantages of the prior art. In particular, the invention is intended to achieve a good storage stability of the bottled beverages and as few foaming losses as possible.

This object is achieved according to the invention by injecting at the foaming means a jet of supercooled, liquid inert gas, in particular nitrogen, in a metered and pressure-controlled manner into a bottle's headspace which is not filled with the beverage, said beverage being preferably beer. To achieve this, a foaming means with a means for injecting a jet of supercooled and liquid inert gas, in particular nitrogen, in a metered and pressure-controlled manner is provided. In the following, the term beer shall be used to represent carbonated beverages in general.

The advantage of foaming the beer according to the invention is firstly that the foam arising from liquid nitrogen foaming has much finer pores than, for instance, that arising from water injection, and thus becomes substantially more gas-tight. The amount of oxygen remaining in the headspace after foaming is very low, and in a range that conventional high-pressure injection systems with comparable overfoaming losses cannot even come close to. Another advantage is that the microporous foam arising from liquid nitrogen injection can be regulated very well with regard to the resultant foam quantity, so foaming losses can be minimized. Thus, the overfoam volumes, which are expensive per se and waste water polluting, can be greatly reduced. There is no longer a gas exchange with the ambient air in the headspace of the filled bottle, but only with the inert nitrogen.

A further advantage of the foaming according to the invention consists in the fact that special plant technologies for preparing germ-free water are no longer required since, as a matter of course, no water is used any more as a foaming agent.

The independent claims define the subject matter of the present invention. Advantageous embodiments are described by means of the sub-claims.

According to a preferred embodiment of the present invention, the bottles pass along a bottling conveyor, a transfer conveyor and a sealing conveyor, with the injection point for the liquid nitrogen being located after the transfer point of the containers from the bottling conveyor to the transfer conveyor. According to such a development, the foaming of the beer is already carried out shortly after bottling, i.e. there is little time for the oxygen-containing ambient air to enter the headspace. This, too, reduces the oxygen percentage in the headspace yet again.

Advantageously, the liquid nitrogen to be introduced into the headspace of the bottle is metered in pulsed fashion or as a permanent flow at one or several points of a metering means contained in the foaming means. The metering quantity and the charging mode can be adjusted in each case as a function of the size and the speed of the containers that pass through.

Preferably, the liquid nitrogen to be introduced into the headspace is high-purified in a purification means contained in the foaming means prior to its being introduced into the headspace. The use of high-pure, sterile nitrogen results in only very small amounts of impurities entering the beer and/or the headspace so that this measure also improves storage stability.

According to a preferred embodiment of the present invention, the amount of the liquid nitrogen entering the headspace is adjusted by means of a controller in the foaming means to a value at which no excessive overpressure is built up in the containers, so that damage to the containers can be avoided.

The liquid supercooled nitrogen is advantageously injected into the headspace onto the surface of the beer at a regulatable overpressure ranging from about 2 to 20 bar. The foaming of the beer is brought about by the kinetic energy of the hard jet of the liquid nitrogen. Since different beers also foam differently, the overpressure with which the liquid nitrogen is introduced into the headspace can in each case be adjusted so accurately that foaming losses are minimized while, at the same time, the greatest possible amount of oxygen is expelled.

In order to prevent ambient air from being entrained with the introduction of the jet of liquid nitrogen into the headspace, a means is provided in a preferred embodiment of the present invention which surrounds the nitrogen jet with a haze of gaseous nitrogen. Thus, if it is not possible to prevent ambient gas from being entrained, the gas entering the headspace in this fashion will again only be inert nitrogen.

In the device according to the invention the foaming means comprises a pressure control means which brings the nitrogen to be injected into the headspace onto the surface of the beer to a liquid supercooled condition at a controllable overpressure ranging from about 2 to 20 bar.

The foaming means of the device according to the invention comprises preferably a feeder for gaseous nitrogen, a feeder for liquid nitrogen, a pressure control and metering means for the liquid nitrogen to be delivered, a charging pipeline for feeding the liquid nitrogen to the injection point, a capillary tube and an exhaust pipe.

The capillary tube for the supercooled, pressurized liquid nitrogen has a diameter of 0.3 to 0.7 mm, preferably of about 0.5 mm.

The outer diameter of the capillary tube ranges from 1.3 to 1.9 mm in an embodiment of the device according to the invention and is preferably 1.6 mm. In the thus defined range for the line and/or nozzle cross-section, suitable heat exchange takes place through the tube cross-section, so that the nozzle does not clog due to icing.

The charging pipeline can extend horizontally, while the nozzle at its end extends vertically after a portion that is bent downwards. However, the entire foaming means is preferably arranged in such a fashion that the charging pipeline and the nozzle extend vertically in one line so that disadvantageous effects caused by deflection of the liquid nitrogen jet can be avoided.

According to a preferred embodiment of the device according to the invention, the capillary tube consists of stainless steel or advantageously of a material with a low heat conductivity, in particular of polytetrafluoroethylene. This choice of material, as well, enables advantageous heat flow, thus avoiding nozzle icing.

The inner diameter of the capillary tube and the pressure of the delivered nitrogen must be adapted to each other in order to be able to set the optimum amount of liquid nitrogen for foaming in each case. The advantages described above can be achieved as a result of the interaction of all setting measures to be taken, i.e. pressure control of the liquid nitrogen, suitable metering and suitable design of the capillary tube. Foaming losses can in particular be reduced by 50% or more as compared with the prior art.

The invention is explained in the following by means of the appended Figs.

Fig. 1 shows an elevation of a device according to the invention for headspace inertization, in particular a foaming means,

Fig. 2 shows a cross-section through a capillary tube for supercooled, pressurized liquid nitrogen, which is used in the device according to the invention,

Fig. 3 shows a top view of a headspace inertization means according to the invention and its arrangement with respect to a bottling conveyor, a transfer conveyor and a sealing conveyor for bottles, and

Fig. 4 shows a schematic view of the pressure and/or temperature control and metering means in the foaming means according to the invention.

Fig. 1 shows an elevation of an embodiment of a device according to the invention for headspace inertization. The foaming means of this device is designated in general with the reference numeral 10. It comprises a pressure and/or temperature control and metering means 15 which is firmly anchored to the floor next to a transfer conveyor 33 indicated in dash-dotted lines. The transfer conveyor 33 conveys bottles 18 already filled with beer from a bottling conveyor 31 to a sealing conveyor 32 (cf. Fig. 3).

A feeder 11 for gaseous nitrogen is represented as a connection at the upper part of the pressure and/or temperature control and metering means 15. A manometer 12 is attached to this connection with which the pressure of the inflowing gaseous nitrogen can be monitored. Moreover, the connection 13 for the feeding of liquid nitrogen (also called LIN in the following) is affixed at the upper part of the pressure and/or temperature control and metering means 15. Finally, the third component, a flue pipe, which is located at the upper part of the means 15, is designated with the reference numeral 14.

The pressure control and metering means 15 prepares a flow of liquid nitrogen flowing in pulsed or permanent fashion from the infed nitrogen flows, which is introduced into the charging pipeline 16. This flow of liquid nitrogen is subcooled and is at a pressure level of 2 to 20 bar overpressure when it leaves the bent capillary tube 17 which adjoins the charging pipeline 16, and is injected as a jet into the headspace of a bottle 18 onto the surface of the beer contained therein. The pressure, the temperature and the amount of the supercooled liquid nitrogen jet to be delivered are adjusted in the pressure control and metering device 15 in such a fashion that a nitrogen jet is always injected for a specific type of beer with a predetermined carbonization and/or a predetermined CO_2 content which effects a foaming in the beer, but does not result in high foaming losses. The aforementioned parameters of the liquid nitrogen jet are always adjusted in such a fashion that the jet still remains in liquid condition upon its exit from the capillary tube 17 (cf. Fig. 2), i.e. also in the case of an expansion to ambient pressure. Thus, a "hard" liquid nitrogen jet impinges onto the surface of the beer filled into the bottle and induces foaming due to its kinetic energy. In the optimum case, the nitrogen jet impinges onto a black surface.

The foaming of the bottled beer results, if a nitrogen jet is used, in a highly microporous foam which displaces the gas volume contained in the bottle up to then due to its rising in the headspace of the bottles 18. Because of its microporosity, the resultant foam is highly gas-tight and effects a type of piston flow in the bottleneck. Due to this, only a very small amount of the original gas volume remains in the headspace; the gas tightness of the microporous foam alone prevents air from the environment from entering the headspace. As a result of this process, the oxygen content in the headspace is brought to a very low value when the bottles 18 are sealed, a result that conventional high-pressure water injections in which large-pore foam is formed do not even get close to achieving. With such a small amount of oxygen in the headspace, the risk of germ formation is minimized. The storage stability of the filled beer is greatly improved. Due to the exact metering and the adjustability of the values for the pressure and/or the temperature of the injected nitrogen jet, an exactly controllable foaming takes place, and overfoaming losses are largely prevented so that high pollutant loads in the waste water can also be prevented.

In Fig. 2, the end of the capillary tube 17 is represented in its cross-section. Stainless steel tubes with a small wall thickness can be used; plastic materials such as polytetrafluoroethylene are also used with preference.

Suitable wall thicknesses for the capillary wall 21 are an inner diameter ranging from 0.3 to 0.7 mm, preferably of 0.5 mm. The outer diameter range for the tube wall 21 can be defined as 1.3 to 1.9 mm, preferably 1.6 mm.

A top view of the headspace inertization means according to the invention is again shown in Fig. 3. The arrangement of the foaming means 10 with the pressure control and metering means 15, the charging pipeline 16 and the capillary tube 17 in relation to the conveying facilities for the bottles 18 is made clear in this view. Filled bottles 18 are delivered by a bottling conveyor 31 that rotates clockwise, and is partially shown at the lefthand side, to a transfer conveyor which rotates counter-clockwise. Just behind the transfer point, the subcooled, pressurized liquid nitrogen is injected into a bottle 18 positioned on the transfer conveyor 33. This injection takes place that shortly after the filling of the bottles 18 so that as little ambient air as possible can enter the headspaces of the bottles 18 during transfer. The injection takes place according to the functional principle described above. During transport on the transfer conveyor 33, the beverage liquid contained in the bottles 18 foams, so that no ambient air can enter the headspace of the bottles 18 until the bottles are sealed in the sealing conveyor 33 which adjoins the transfer conveyor 33.

At this point, further possibilities of nitrogen injection which are not shown will be explained.

One possibility consists in arranging the foaming means 10 in such a fashion that it is located directly above the injection point so that the charging pipeline and the adjoining capillary tube extend in a straight line. This avoids disadvantageous effects due to deflection of the jet of liquid nitrogen.

A further development possibility consists in providing a means at the injection point which surrounds it with a haze of gaseous nitrogen. This prevents atmospheric oxygen from the environment from being entrained by the jet of liquid nitrogen into the headspace of the bottles 18.

A pressure control and metering means 15 for the liquid nitrogen to be delivered is schematically represented in Fig. 4. At the upper lefthand, two feeding means for liquid nitrogen 13 and gaseous nitrogen 11 are represented. These lead into the means 15 with the interposition of pressure and/or temperature control means 41, 42, 43, 44, 46, 47.

Furthermore, the metering and/or pressure control is implemented by control elements 40, 45, 48, 49 which are located in the intermediate pipelines. As shown at the lower side, a jet of liquid subcooled nitrogen (LIN), which is at an overpressure of 2 to 20 bar, depending upon the requirements to be met by foaming, exits from the pressure control and metering means 15. This is the nitrogen flow which is introduced into the charging pipeline 16 (cf. Figs. 1 and 3). As indicated at the upper side of the means, gaseous nitrogen N_2 exits which is delivered to the exhaust pipe 15 shown in Fig. 1 and is blown off.

As already mentioned, the metering and the pressure of the nitrogen jet to be delivered are adjusted, also in relation to the dimensions of the capillary tube 17 and the charging pipeline, by means of the control system shown in Fig. 4 in such a fashion that an optimum jet of liquid nitrogen can be injected in each case for different foaming applications.

Although the invention has been described so far with regard to bottling and beer foaming, it is understood that the process and the device according to the invention can also be used for headspace inertization and the foaming of other beverages, e.g. soft drinks, etc., in particular carbonated beverages.

Claims

1. A process for the inertization of the headspace of bottles (18) filled with carbonated beverages, preferably with beer, comprising the following steps:

a) after the filling of the beverages, in particular beer, into the bottles (18), the bottles are transferred to a foaming means (10),

b) a jet of subcooled, liquid inert gas, in particular nitrogen, is introduced in a metered and pressure-regulated fashion into the headspace of the bottle (18), which is not filled with the beverage,

c) due to the resultant foaming, the gas volume previously contained in the headspace is displaced from it, and

d) the bottles (18) are sealed.

2. A process according claim 1, characterized in that the bottles (18) pass through a bottling conveyor (31), a transfer conveyor (33) and a sealing conveyor (32, the introduction point for the liquid nitrogen being located after the transfer point of the bottles (18) from the bottling conveyor (31) to the transfer conveyor (33).

3. A process according to any of claim 1 or 2, characterized in that, for the introduction of the liquid nitrogen into the headspace of the bottle (18), the liquid nitrogen is metered at one or several points of a metering means (15) in pulsed fashion or as a permanent flow.

4. A process according to any of claims 1 to 3, characterized in that the liquid nitrogen to be introduced into the headspace is high-purified prior to introduction.

5. A process according to any of claims 1 to 4, characterized in that the amount of the liquid nitrogen to be introduced into the headspace is adjusted to a value at which no excessive overpressure is formed in the sealed bottles (18).

6. A process according to any of claims 1 to 5, characterized in that liquid subcooled nitrogen is injected into the headspace onto the surface of the beverage at a controllable overpressure ranging from about 2 to 20 bar.

7. A process according to any of claims 1 to 6, characterized in that the jet of the liquid nitrogen is surrounded by a haze of gaseous nitrogen in order to avoid the entraining of ambient air into the headspace.

8. A device for inertization of the headspace of bottles filled with carbonated beverages, preferably with beer, comprising:

a) a means (31) for filling the beverage into the bottles (18),

b) a foaming means (10) to which the bottles (18) are transferred after having been filled and by means of which the gas volume previously existing in the headspace of the bottles (18) is displaced from it due to the resultant foaming, and

c) a sealing means (32) for the bottles (18), characterized in that

d) the foaming means (10) comprises a means (15, 16, 17) for the metered and pressure-regulated introduction of a jet of supercooled liquid inert gas, in particular nitrogen, into the headspace of the bottles (18) not filled with the beverage.

9. A device according to claim 8, characterized by a bottling conveyor (31), a transfer conveyor (33) and a sealing conveyor (32), the introduction point for the liquid nitrogen being located behind the transfer point of the bottles (18) from the bottling conveyor (31) to the transfer conveyor (33).

10. A device according to any of claims 8 or 9, characterized by a metering means (15) for introducing the liquid nitrogen into the headspace of the bottles (18) with which the liquid nitrogen is metered in pulsed fashion or as a permanent flow at one or several points.

11. A device according to any of claims 8 to 10, characterized by a purification means by means of which the liquid nitrogen to be introduced into the headspace is high-purified prior to its introduction.

12. A device according to any of claims 8 to 11, characterized by a controller which adjusts the amount of the liquid nitrogen to be introduced into the headspace to a value at which no excessive overpressure is formed in the sealed bottles (18).

13. A device according to any of claims 8 to 12, characterized by a pressure control means (15) by means of which the nitrogen to be injected into the headspace onto the surface of the beverage is brought to a liquid subcooled condition at a controllable overpressure ranging from about 2 to 20 bar.

14. A device according to any of claims 8 to 13, characterized by a foaming means (10) comprising

- a feeder (13) for gaseous nitrogen,
- a feeder (11) for liquid nitrogen,
- a pressure and/or temperature control and metering means (15) for liquid nitrogen to be delivered,
- a charging pipeline (15) for feeding the liquid nitrogen to the injection point,
- a capillary tube (17) at the end of the charging pipeline (16) for delivering the liquid nitrogen, and
- an exhaust pipe (14).

15. A device according to claim 14, characterized in that the charging pipeline (16) and/or the capillary tube (20) have an inner diameter of 0.3 to 0.7 mm, preferably about 0.5 mm, and an outer diameter of 1.3 to 1.6 mm, preferably about 1.6 mm.

16. A device according to any of claims 14 to 15, characterized in that the charging pipeline (16) and/or the capillary tube (20) consist of stainless steel and preferably of a material with low heat conductivity, in particular of polytetrafluoroethylene.

17. A device according to any of claims 8 to 16, characterized by a hazing means by means of which the jet of the liquid nitrogen is surrounded by a haze of gaseous nitrogen in order to prevent the entraining of ambient air into the headspace.

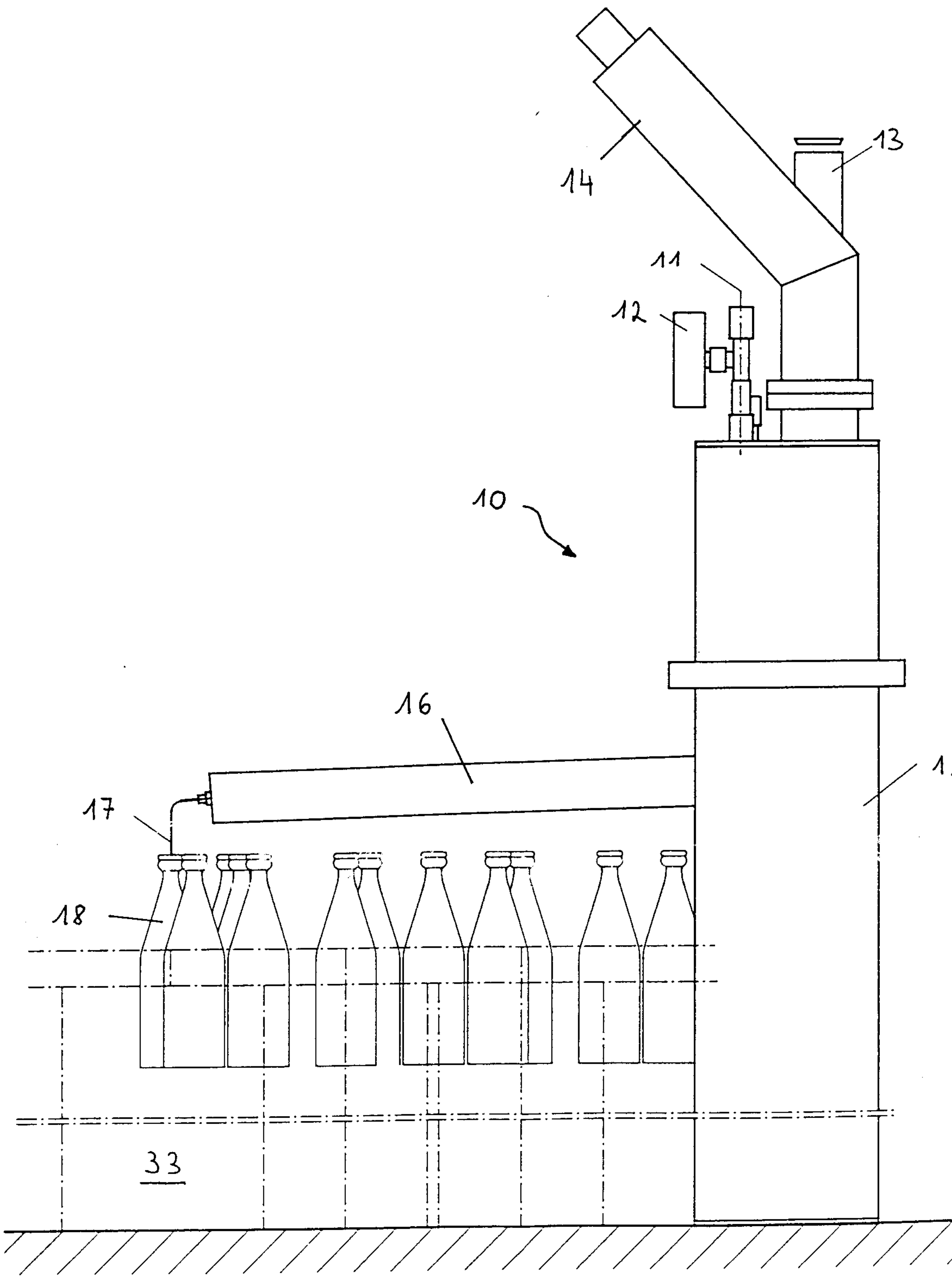

Fig. 1

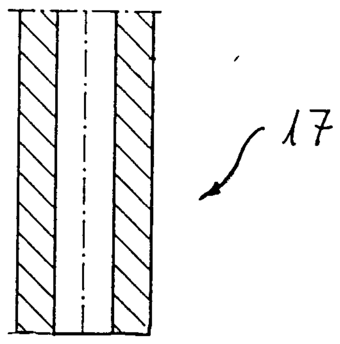

Fig. 2

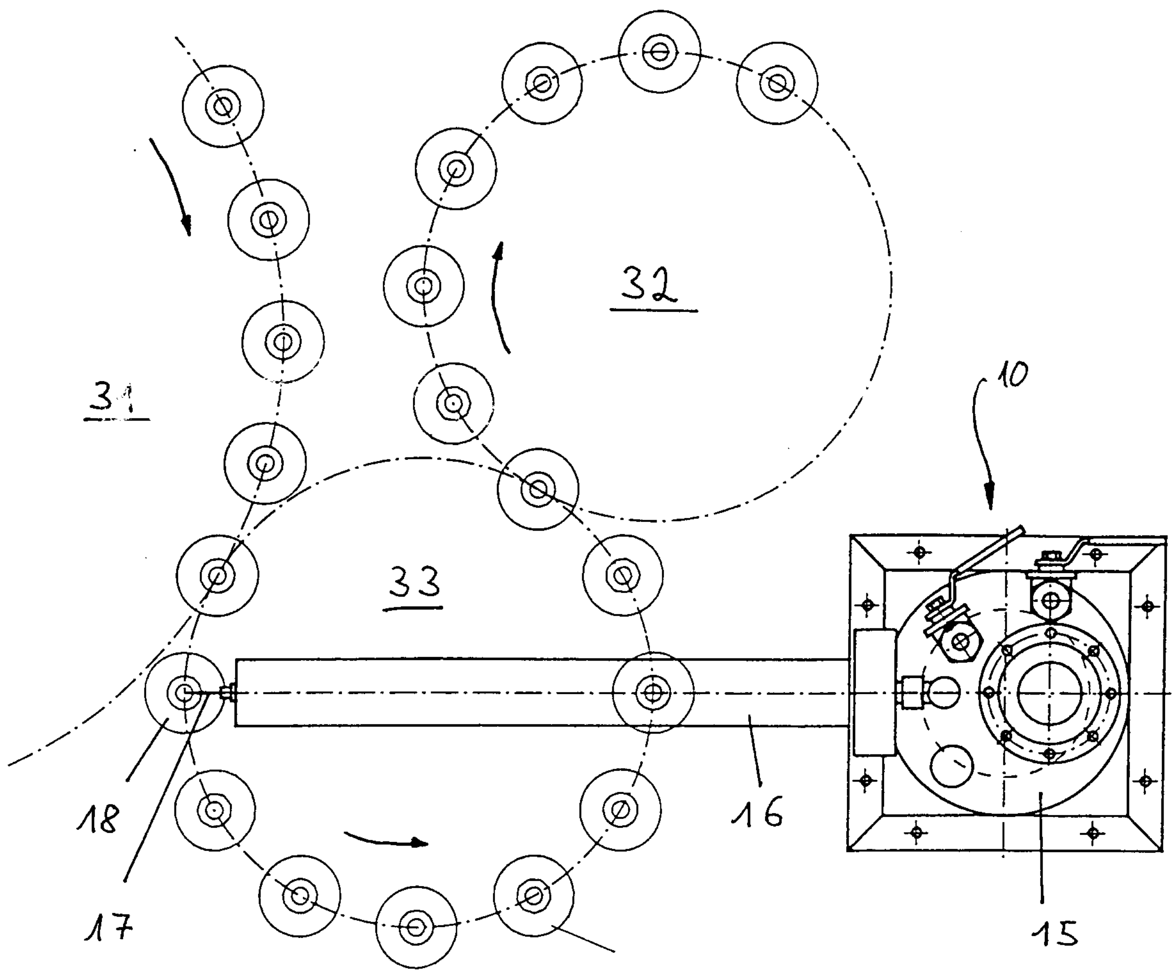

Fig. 3

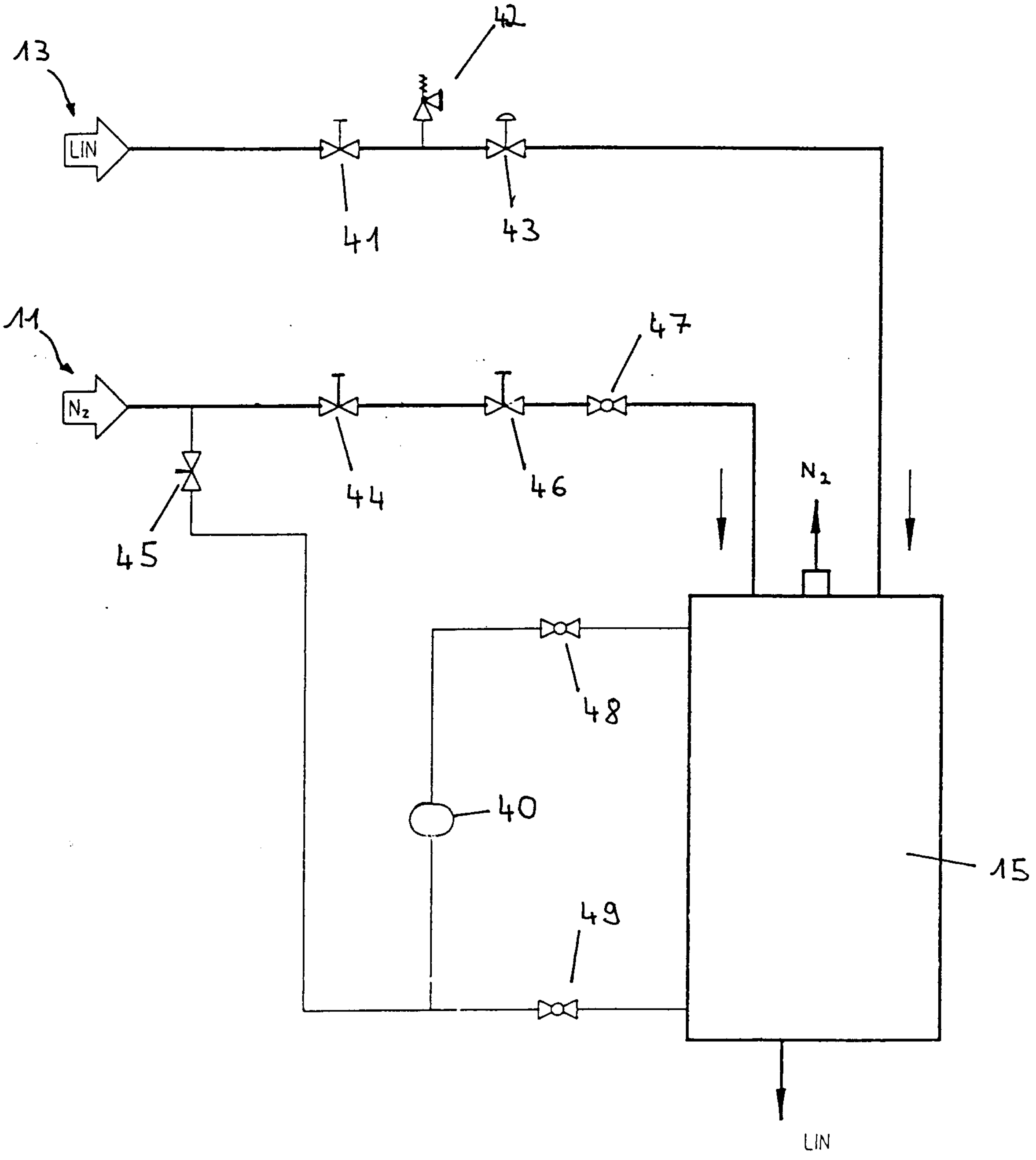

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 96 11 3832

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X Y	EP 0 723 928 A (KRONSEDER MASCHF KRONES) 31 July 1996 * column 2, line 17 - line 20; claims 7,20-22; figure 1 *	1,2,5,8, 9,12 3,6,7, 10,13, 14,17	B67C3/22
Y	EP 0 479 030 A (SEITZ ENZINGER NOLL MASCH) 8 April 1992 * page 4, line 53 - page 5, line 22 *	3,6,10, 13	
Y	DE 21 34 640 A (SEITZ WERKE GMBH) 25 January 1973 * claim 1 *	7,14,17	
A	DE 41 35 438 A (ORTHMANN & HERBST) 29 April 1993 * claims *	1,8	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
B67C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20 January 1997	MARTINEZ NAVAR

CATEGORY OF CITED DOCUMENTS

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