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

(11) Publication number : 0 489 589 A1

(12) EUROPEAN PATENT APPLICATION

(21) Application number : 91311311.4

(22) Date of filing : 04.12.91

(51) Int. Cl.^{5} : **B67C 3/00**, B65B 31/00

(30) Priority : **05.12.90 GB 9026385**

(43) Date of publication of application :
10.06.92 Bulletin 92/24

(84) Designated Contracting States :
BE CH DE DK ES FR GB GR IT LI NL SE

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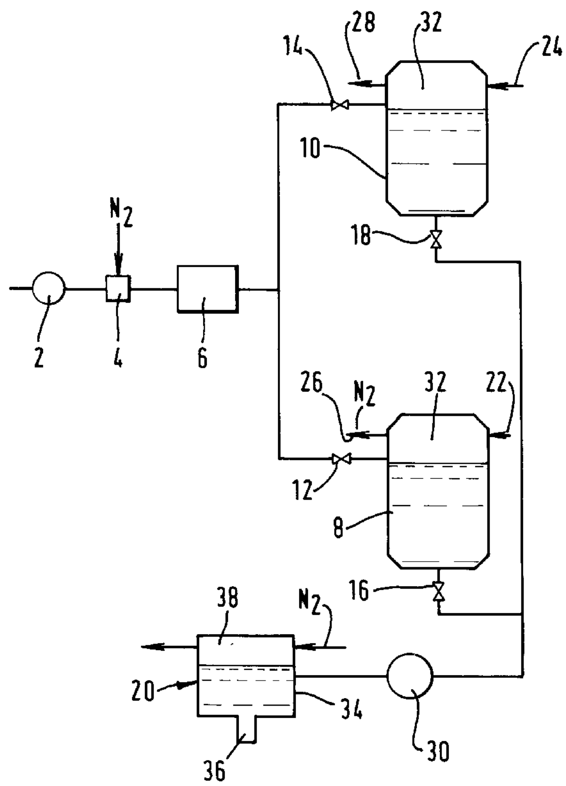
(54) Dissolving a gas in a liquid.

(57) In the canning of a non-carbonated liquid food product, nitrogen is dissolved in the product in a gas dissolution device 4, the product is held under nitrogen pressure in a holding tank 8 or 10 for a period of time sufficient to permit froth to subside, and the product is then used to fill the cans from a filler 20. The cans are thereupon closed fluid-tight. The nitrogen comes out of solution in each closed can to create a superatmospheric pressure therein. Accordingly, flexible thin-walled cans can be used.

FIG. 1



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This invention relates to dissolving a gas in a liquid a part of a process in which flexible containers such as thin walled cans, typically formed of aluminium or steel, and plastics bottles, are charged with the liquid.

In the canning and bottling industries there has been a trend in recent years to substitute containers having flexible walls for the traditional rigid steel can and rigid glass bottle when canning or bottling an artificially carbonated beverage. The canning or bottling process includes saturating the beverage with carbon dioxide under pressure, and then discharging the beverage under pressure into open containers to be filled. The containers are then closed and sealed. Carbon dioxide comes out of solution in the sealed container and thus creates a pressure in the head space of each sealed can sufficient to resist deformation of the of its walls during normal handling and stacking. Typically, more than 2.5 volumes of carbon dioxide are dissolved in each volume of liquid (when measured at 15°C) in order to create the necessary super-atmospheric pressure in the head space of each can. In some beverages, particularly soft drinks, such a level of carbonation is deemed not to have an adverse effect on the quality of the beverage, and is frequently believed to be beneficial. There are, however, a large number of other liquid food products, including other beverages, in which such levels of carbonation are unacceptable. Indeed, many liquid food products are required to be free of dissolved carbon dioxide. Accordingly, modern flexible thin walled containers cannot be used for their packaging unless another means of providing an internal pressure above atmospheric is provided.

Most attempts to provide such other means have been based on the use of the so-called liquid nitrogen droplet dispenser. This is a device which delivers a small metered quantity of liquid nitrogen to each filled container before the latter is sealed. The liquid nitrogen vaporises almost instantaneously and is thereby able to create a super-atmospheric pressure in the head space of the vessel, bearing in mind that 1 volume of liquid nitrogen will produce in the order of 600 volumes of nitrogen gas. Since modern canning lines can operate at speeds up to and over 2,000 cans per minute, there have been considerable problems in designing such a droplet dispenser so as to be able to deliver up to 2,000 equal unit quantities of liquid nitrogen per minute. To date, these problems have not been fully solved and there tends to be noticeable variation beyond what is acceptable in the head space pressure of the sealed cans even at canning line speeds well below 2,000 cans per minute. Another difficulty often associated with the operation of liquid nitrogen droplet dispensers is that whereas it is conventional in canning to blow a non-oxidising gas such as nitrogen or carbon dioxide over the mouth of the of the open container once it has been filled and up to the time when it is sealed, the rates of flow of non-oxidising gas that are optimum for this purpose tend to draw nitrogen vapour out of the head space of the can and give rise to undue variations in the internal pressure of the sealed can. Accordingly, lower than optimum flows of non-oxidising gas across the mouth of the open container tend to be used with the result that the oxygen content of the head space of each sealed container is higher than is ideal. Thus, an alternative to the liquid nitrogen droplet dispenser is needed.

There are indeed a number of alternative proposals in the art. For example, US patent specification 4 347 695 discloses a beverage bottling or canning method for non-carbonated beverages. An inert gas, other than carbon dioxide, such as nitrogen is injected into a non-carbonated beverage. The resulting beverage containing dissolved nitrogen is then introduced into a cooler through which it passes on the way to a filler which is employed to charge the cans or bottles with the nitrogenated beverage. Inert gas is permitted to escape from the beverage in the filled container before sealing the container. The amount of gas released is sufficient to strip dissolved oxygen from the beverage and then purge air from the head space of the container. Sufficient gas is retained in the beverage to exert a super-atmospheric pressure after the container is sealed. The reduction in oxygen content of the head space is stated to be superior to that achieved when passing a stream of nitrogen purging gas into the head space. It is further disclosed that in order to avoid or minimise the formation of excessive foam, the gas is preferably metered and injected into a flowing stream of the beverage. The minimising of the formation of excessive foam is defined as meaning that when containers are filled to a conventional volume, liquid is not carried beyond the closure of the container.

GB-A-2 134 496 nominally relates to filling thin walled cans with non-fizzy or substantially non-carbonated drinks. In the process described therein it is, however, required to use carbon dioxide in addition to nitrogen to create an internal can pressure. Such use of carbon dioxide is unacceptable in many liquid food products.

GB-A-2 203 417 relates to charging a flexible container such as a can or plastics bottle with non-carbonated liquid. Argon is dissolved in the liquid. The liquid is then passed to a filler bowl and the containers are filled with the liquid therefrom. The containers are then sealed. In view of the greater solubility of argon than nitrogen, relatively higher head space pressures can be created thereby. Unfortunately, argon is not an approved food additive in the United Kingdom and other countries, and this drawback has lead to a delay in the commercial exploitation of the method described in GB-A-2 203 417.

GB-A-2 089 191 discloses creating a super-atmospheric pressure in a sealed container by pre-dissolving an inert gas in a liquid food before the container is filled with the food. The gas is dissolved in the liquid food in a gasifying device on its way to the canning filling station.

FR-A-2 636 918 discloses a method in which in order to fill a thin walled container with a fruit juice, nitrogen is dissolved in refrigerated water and the resulting nitrogenated water is mixed with deoxygenated concentrated fruit juice in line on its way to the filling station. The containers are then filled and sealed and the nitrogen comes out of solution to create the necessary super-atmospheric pressure therein. This method has the disadvantage that mixing the chilled water with the deoxygenated fruit juice will reduce the level of dissolved nitrogen in the water and hence limit the maximum pressure that can be created in the container.

Only one of the above discussed prior patent specifications (namely US-A-4 347 695) addresses the problem of foaming of the liquid, suggesting that such foaming (sometimes known as "fobbing") can be minimised. We have discovered that this is not a realistic appreciation of the situation that arises in commercial practice. Many liquid food products contain surfactants or other substances which promote foaming. Moreover, nitrogen tends to interact with such substances to create relatively stable foams. Accordingly, with many liquid food products, foaming is for practical purposes impossible to avoid when dissolving nitrogen.

It is an aim of the present invention to provide a method of charging containers having flexible walls with a liquid food product in which nitrogen is dissolved in the liquid so as to enable a suitable head space pressure to be created in each sealed container and whose operation is not adversely affected by the creation of foam when filling the containers.

According to the present invention there is provided a method of charging containers having flexible walls with a non-carbonated liquid food product, comprising the steps of dissolving nitrogen in the liquid food product, holding the liquid food product containing dissolved nitrogen for a period of at least 10 minutes under a pressure of nitrogen, said period being of sufficient duration for foam formed during the dissolution of the nitrogen to subside, and then introducing the liquid into the containers and thereafter closing the containers gas-tight, the concentration of dissolved nitrogen in the liquid that is introduced into the containers being such that after their closure dissolved nitrogen is able to come out of solution in each container to create therein a super-atmospheric internal pressure that resists deformation of its walls during normal handling.

If it is desired to deliver continuously a volume of liquid in excess of that of a vessel in which the liquid food product is held under the said nitrogen pressure, then a plurality of holding vessels may be used, whereby one or more are used to deliver nitrogenated liquid to a filling station, while the other or others are being charged with or holding the nitrogenated liquid food product. Alternatively, a single holding vessel may be employed, the vessel having an outlet of liquid located sufficiently below the inlet for liquid that liquid free of foam may be continuously withdrawn from the outlet.

Preferably, the liquid food product has nitrogen dissolved in it under a pressure of nitrogen in excess of the holding pressure. Typically, the dissolving pressure is in the range of 3 to 6.5 atmospheres absolute and the holding pressure is in the range of 2 to 3.5 atmospheres absolute.

Preferably, sufficient nitrogen is brought into contact with the liquid food product to saturate it with nitrogen at the dissolving pressure, although it is to be appreciated that not all this nitrogen may be dissolved, and indeed it is generally not essential to saturate the liquid food product at the dissolving pressure.

Any conventional apparatus for dissolving nitrogen in a liquid may be used. Preferably, the nitrogen is dissolved in a turbulent, pressurised stream of the liquid food product. Moreover, the technique of introducing the nitrogen into the liquid food product is preferably one which facilitates the formation of small bubbles of nitrogen. For example, the nitrogen may be introduced into the stream through a venturi. The shape of the venturi naturally creates turbulence in the stream which helps to dissolve the nitrogen. An alternative technique is to use a sparger, which is a pipe having a plurality of orifices of small size (for example 0.012 mm each) typically located within the pressurised stream so as to create turbulence by its presence.

Dissolution of nitrogen is considerably facilitated if a turbulent stream of the beer containing undissolved nitrogen bubbles is passed through a heat exchanger of the plate or plate-fin type whereby the plates provide an enhanced surface area of the transfer of nitrogen from the gas phase to liquid phase. Thus, an appreciable quantity of nitrogen is dissolved as the liquid nitrogen food product passes through the chiller. The chiller also preferably adjusts the temperature of a liquid food product such that it leaves the chiller at a temperature at or close to 0°C. The resulting stream leaving the chiller is typically in the form of a foam.

The nitrogenated liquid food product may be held for a substantial period of time with a concentration of nitrogen such that, at the end of the holding period, there is sufficient dissolved nitrogen to provide adequate internal container pressure on completion of the method according to the invention.

In order to maintain the holding pressure at a desired value, nitrogen is desirably passed into the head space of the holding vessel without its passing through the liquid food product.

The step of introducing the liquid food product into the containers typically includes transferring the nitrogenated liquid food product from the holding vessel to a filling vessel. The filling vessel may for example be a conventional filler bowl. While it is resident in the filling vessel, the nitrogenated liquid food product is preferably held under a pressure of nitrogen at least equal to the pressure of nitrogen under which the beer is held in the holding vessel. Accordingly, a positive displacement pump is preferably used to transfer the liquid food product from the holding vessel to the filling vessel. If desired, a buffer vessel may be employed intermediate the holding vessel and the filling vessel. By avoiding the use of a pressure transfer system relying on a pressure difference between a higher pressure in the holding vessel and a lower pressure in the filling vessel to effect transfer of the liquid food product, it becomes possible to avoid any substantial reformation of foam as the liquid food product flows from the holding vessel to the filler vessel. A pressurised nitrogen atmosphere is preferably provided in the head space of any buffer vessel. When filling flexible walled containers, (e.g. thin walled cans or plastics bottles) by the method according to the invention, it is preferred to pass nitrogen at a low pressure (e.g. 0.4 psig) over the mouth of each can as it is filled and up to the time a lid is sealed to the can (the sealing steps sometimes being referred to in the art as "seaming"). Such nitrogen flow helps to minimise the amount of air that enters into the head space of the cans after filling and before closure.

During the short period of time between discharging a volume of liquid food product from the filler and closing the container which is charged with the liquid food product, there is tendency for nitrogen to come out of solution because in this period liquid food product is subjected to the ambient atmosphere which is at a lower pressure than that maintained in the filler. Accordingly, this period is typically kept to a very short duration by operating the canning line at or near to its maximum speed.

As well as helping to reduce oxygen levels in closed cans, the blowing of nitrogen over the surface of the liquid food product therein immediately prior to closure of the cans helps, we believe, to enhance the equilibrated can pressure. It is to be appreciated that shortly after closure, not all of the gas, which may subsequently come out of solution in the liquid held in the can, would typically have done so. Equilibration can be brought about by shaking or otherwise disturbing the can so as to ensure good contact between the gas phase and liquid phase therein such that an equilibrium can be established between the dissolved gas in the liquid and the gas in the head space of the cans.

If the liquid food product requires deoxygenation, then this step is preferably performed upstream of said step of dissolving the nitrogen therein. If desired, the deoxygenation may be performed by passing nitrogen bubbles through the liquid so as to drive dissolved oxygen out of solution. Although such a deoxygenation step will help to provide some dissolved nitrogen in the liquid food product, this level will be well below that necessary for creation of a pressure in each filled container sufficient to resist deformation during normal handling.

If the liquid food product is formed by mixing two or more liquids, the step of mixing is preferably performed upstream of said step of dissolving nitrogen in the liquid food product.

The flexible containers may be charged with any one of a wide range of different liquid food products that have been nitrogenated in accordance with the invention. The liquid food product may for example be a fruit juice, milk, a soft drink, wine, an edible oil, or a vegetable juice.

The method according to the invention will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a schematic flow diagram of a first apparatus for filling cans with a liquid food product; and

Figure 2 is a schematic flow diagram of an alternative apparatus for filling cans with a liquid food product.

Referring to Figure 1 of the drawings, a stream of deoxygenated liquid food product is pumped at a pressure of 5 atmospheres absolute by a pump 2 through a gas dissolution device 4 of a kind in which the gas to be dissolved is introduced into a turbulent stream of the liquid food product through a sparge pipe (not shown) having a multiplicity of small orifices for the gas to be dissolved. A stream of nitrogen, typically at a pressure of 6 atmospheres absolute, is introduced into the turbulent stream of liquid food product flowing through the gas dissolving device 4. The nitrogen enters the turbulent stream of liquid food product in the form of bubbles. The ratio of the volumetric rate of flow of nitrogen into the gas dissolution device 4 to that of the liquid stream is typically 1 to 3. The dissolution device 4 is typically operated at a temperature between 0 and 4°C. The resulting turbulent stream of liquid food product containing dissolved nitrogen and undissolved bubbles of nitrogen then flows to a chiller 6 which is of a plate-fin kind. While some nitrogen bubbles dissolve upstream of the chiller 6, further dissolution of the nitrogen takes place in the chiller 6 as a result of the enhanced liquid-gas contact that the chiller 6 provides. As a result of the intimate contact between the nitrogen and the liquid, the stream of liquid food product leaves the chiller 6 in the form of a foam.

Holding tanks 8 and 10 are provided for the nitrogenated liquid food product. Manually or automatically operable stop valves 12 and 14 associated with the tanks 8 and 10 respectively are operable to place either of the tanks 8 and 10 in communication with the outlet of the chiller 6. The tanks 8 and 10 are employed first to receive the nitrogenated liquid food product and hold it under nitrogen pressure, the holding period being of sufficient duration to allow the foam to subside, and second to deliver the liquid to a filler 20. The valves 12 and 14 are operated so that while the tank 8 receives and holds nitrogenated liquid food product, the tank 10 delivers to the filler 20 liquid food product that has been held for a sufficient period of time to enable foam to subside. Once the liquid from the tank 10 has been delivered to the filler 20, the roles of the two tanks 8 and 10 are reversed, and the tank 8 is used to deliver liquid food product and the tank 10 to receive and hold such product. Each of the tanks 8 and 10 has an outlet at its bottom through which liquid is delivered to the filler 20. The tank 8 has a manually or automatically operable on-off valve 16 located in its outlet, and the tank 10 a similar manually or automatically operable stop valve 18 located in its outlet. Accordingly, by appropriately opening and closing the respective valves 12, 14, 16 and 18, continuous delivery of the nitrogenated liquid food product to the filler 20 is made possible. This enables continuous production of canned liquid food product to be effected.

Prior to commencement of the delivery of the liquid food product to a selected tank 8 or 10, both tanks 8 and 10 are purged, and then filled, with nitrogen under pressure. This pressure is, for example, 3 atmospheres absolute, which pressure is maintained in the ullage space of each tank by having a continuous flow of nitrogen into and out of the ullage space 32 thereof via respective inlet pipes 22 and 24 and outlet pipes 26 and 28. Typically, the holding period of the liquid food product in a chosen tank is typically at least one hour. At the end of this period the foam has almost completely subsided. This enables the exact quantities of liquid food product to be dispensed from the filler 20 to each can.

Transfer of the liquid food product from a chosen tank 8 or 10 to the filler 20 is effected by a positive displacement pump 30. The filler 20 comprises a filler bowl 34 having a dispensing nozzle 36 at its bottom. A super-atmospheric pressure of nitrogen, say 3 atmospheres absolute, is maintained in the ullage space 38 of the filler bowl 30 by controlled passage of nitrogen therethrough.

Cans (not shown) are advanced one at a time under the filler 20 and filled with a chosen volume of nitrogenated liquid food product. Nitrogen is passed or blown across the open mouth of each can while it is being filled and until its closure. The cans are then closed by means of a lid which is immediately sealed thereto by a seaming machine. The contents of the cans may then be pasteurised.

Typically, from 50 to 100 parts per million (by volume) of nitrogen may be dissolved in the liquid food product. After equilibration, the filled and sealed cans typically have an equilibriated internal can pressure of from 20 to 30 psig (at 20°C).

Referring to Figure 2 of the drawings, the apparatus depicted therein is similar to that shown in Figure 1 and like parts in the two figures are identified by the same reference numerals. The essential difference between the apparatus of Figure 2 and that of Figure 1 is that whereas in Figure 1, two holding tanks 8 and 10 with associated valves 12, 14, 16 and 18 are employed, in the apparatus shown in Figure 2, just one holding tank 50, relatively large in size, is used. The holding tank 50 is operated with a super-atmospheric head space nitrogen pressure of, say, 3 atmospheres absolute. This pressure is maintained by passage of nitrogen into and out of the head space 52, and an inlet 54 and an outlet 56 are provided for this purpose. The capacity of the tank 50 is large enough to enable continuous withdrawal of liquid free of foam from a bottom outlet 58 to be performed while a stream of foam is being received through an inlet 60. Thus, the average residence time of the liquid in the holding tank 50 is sufficient to allow the foam to subside. In other respects, operation of the apparatus shown in Figure 2 is analogous to that shown in Figure 1.

The filler 20 may typically form part of a conventional apparatus for charging cans with a carbonated beverage. The nitrogen dissolving apparatus and the vessels and associated equipment for holding the nitrogenated liquid food product can then be retro-fitted to the filler 20.

Claims

1. A method of charging containers having flexible walls with a non-carbonated liquid food product, comprising the steps of dissolving nitrogen in carbonated liquid, holding the liquid food product containing dissolved nitrogen for a period of at least ten minutes under a pressure of nitrogen, said period being of sufficient duration for foam formed during the dissolution of the nitrogen to subside, and then introducing the liquid into the containers and thereafter closing the containers gas-tight, the concentration of dissolved nitrogen in the liquid that is introduced into the containers being such that after their closure dissolved gas is able to come out of solution in each container to create therein a super-atmospheric internal pressure that resists deformation of its walls during normal handling.

2. A method as claimed in Claim 1, in which bubbles of nitrogen are dissolved in a turbulent stream of the liquid food product.

3. A method as claimed in Claim 1 or Claim 2, in which some of the nitrogen is dissolved in a chiller through which the liquid is passed.

4. A method as claimed in any one of the preceding claims, in which the containers are cans, and each charged can has an internal can pressure of from 20 to 30 psig at 20°C after equilibration.

5. A method as claimed in claim 4, in which the pressure in the head space of the filler is at least equal to the pressure under which the liquid is held to allow the foam to subside.

6. A method as claimed in claim 5, including the step of passing nitrogen into the head space of the filler.

7. A method as claimed in any one of the preceding claims, in which nitrogen is passed over the mouth of each container during filling.

8. A method as claimed in any one of the preceding claims, in which there are a plurality of holding vessels, whereby one or more of the holding vessels are used to receive and hold the nitrogenated liquid food product, while at least one other holding vessel delivers nitrogenated liquid to a container filling station.

9. A method as claimed in any one of claims 1 to 7, in which the nitrogenated liquid food product is held in a single vessel having an outlet located sufficiently below an inlet for liquid free of foam to be continuously withdrawn from the outlet and passed to a container filling station.

10. Containers when filled by a method as claimed in any one of the preceding claims.

FIG. 1

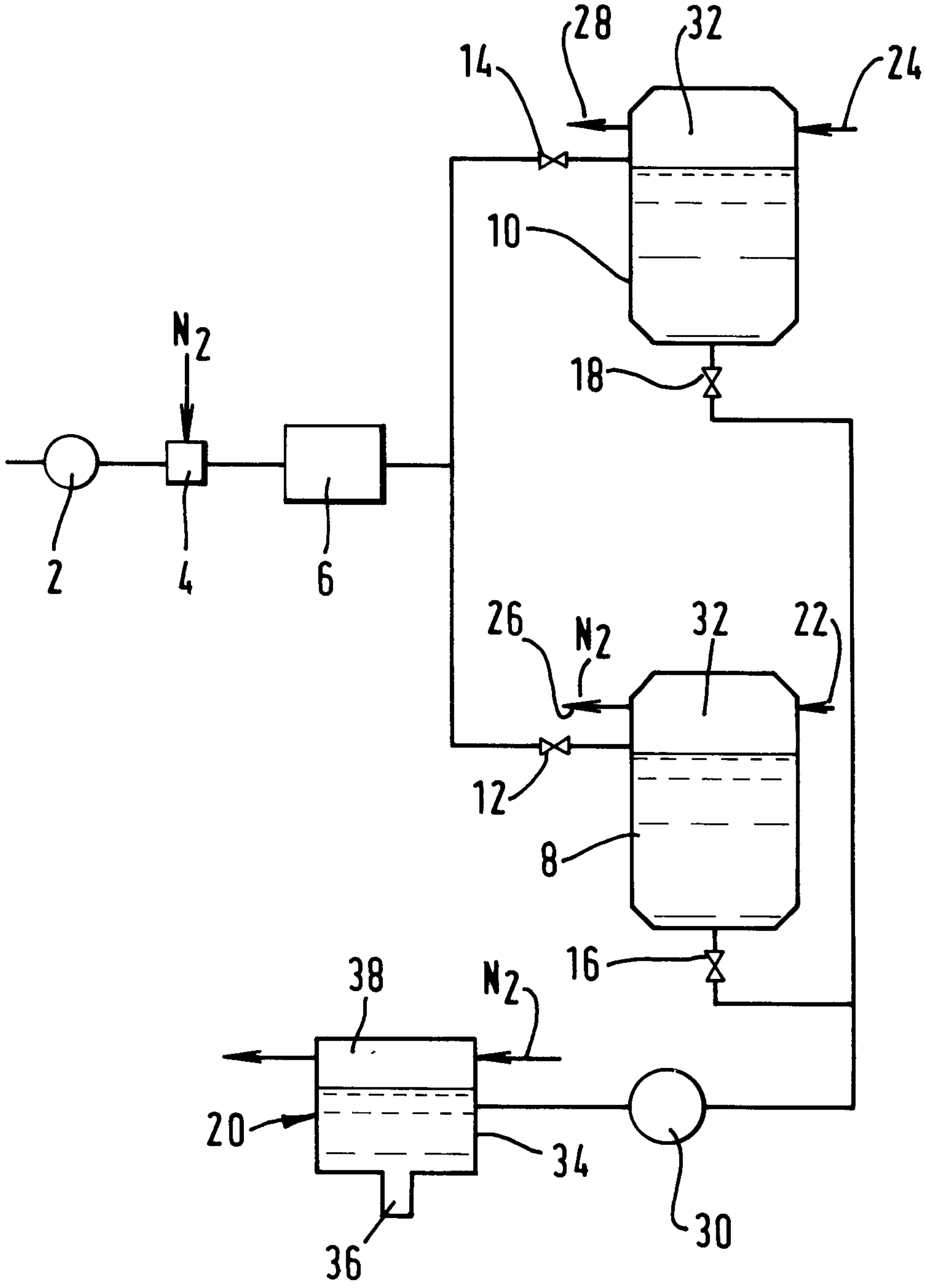
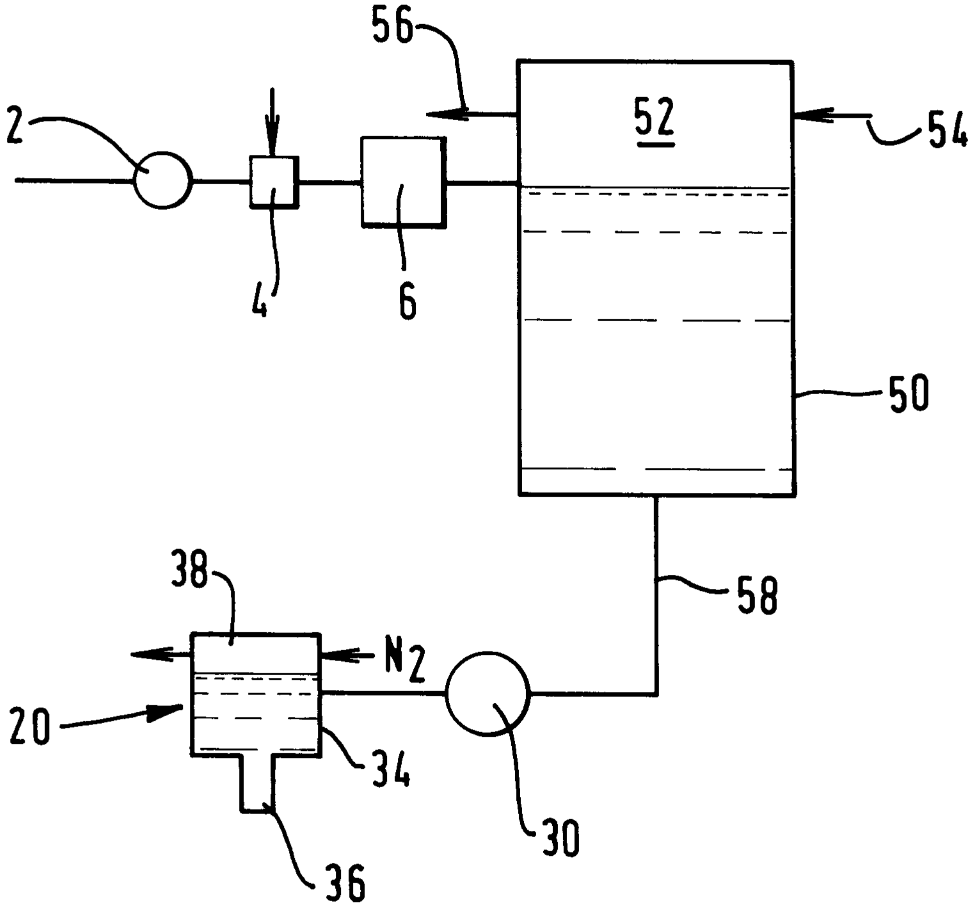


FIG. 2



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EUROPEAN SEARCH REPORT

Application Number

EP 91 31 1311

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.5)
A,D	US-A-4 347 695 (ZOBEL , F.A.) * the whole document * ---	1,10	B67C3/00 B65B31/00
A,D	FR-A-2 636 918 (L'AIR LIQUIDE) * the whole document * ---	1,10	
A,D	GB-A-2 134 496 (ASAHI BREWERIES LTD) * the whole document * -----	1,10	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

B67C
B65B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	09 MARCH 1992	NGO SI XUYEN G.

CATEGORY OF CITED DOCUMENTS

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