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(54) **Carbonation system**

(57) An in-line carbonation system is shown for carbonating water or a noncarbonated pre-mix mixture. A flow restrictor (17) meters a predetermined quantity of pressurized carbon dioxide gas to a T-fitting (23) for combination with a known quantity of the liquid as delivered thereto by a pump (25). The carbon dioxide and liquid flow therefrom through a turbulator (32) for enhancing of the absorption of the gas by the liquid. The liquid and gas then flow through a heat exchange cooling coil (38) for further absorption of the gas as the liquid is cooled in the coil. The coil (38) is connected to a dispensing valve (40) for dispensing of the cooled carbonated liquid.

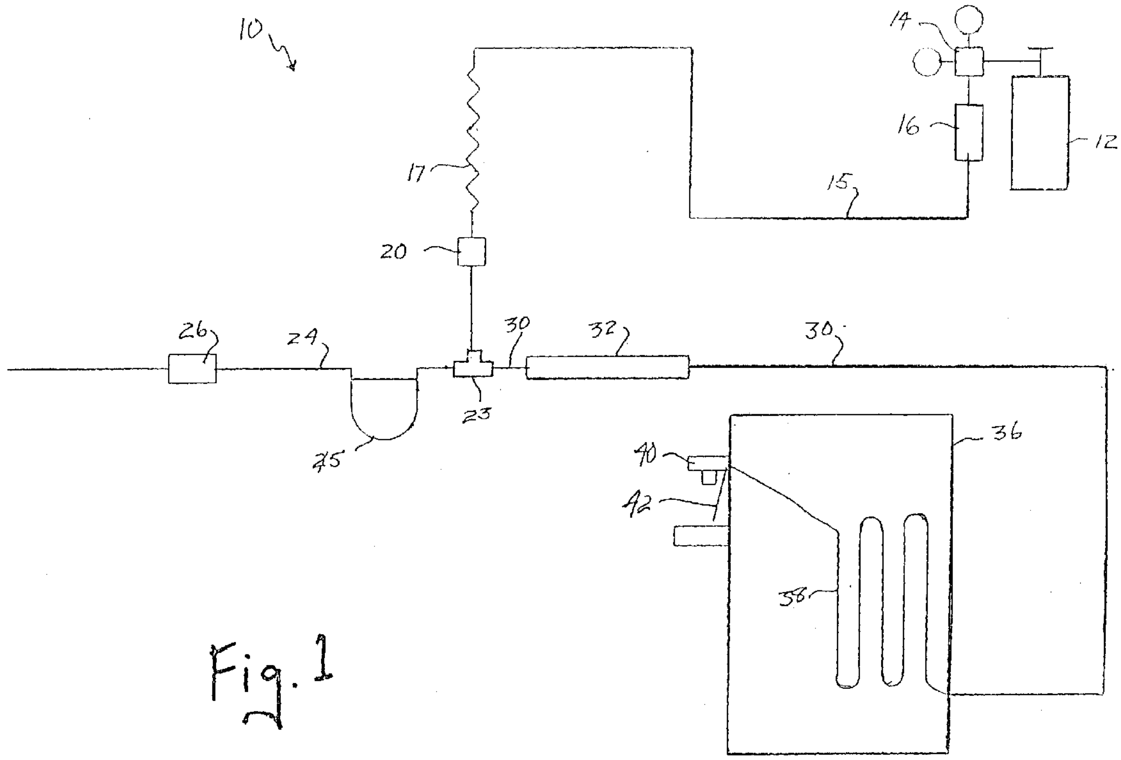

Fig. 1

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Description

The present invention relates generally to equipment used to carbonate beverages or plain water, and in particular to such equipment designed to carbonate in an on demand basis.

Various carbonation systems exist that purport to provide for a more rapid combination of water and carbon dioxide gas for permitting the production of carbonated water on an as needed basis. Such approaches to carbonation offer the possibility of reducing the size of or eliminating the traditional carbonating tank, and providing a volume of carbonated water that is not limited by the size of the tank nor the systems ability to replenish the supply produced therein. Some on-demand systems utilize the strategy of increasing the surface area of contact between the carbon dioxide gas and the water. However, many such systems, while effective in large bottling facilities, do not translate well to the far smaller size constraints of fountain beverage dispensing machines. Other carbonating strategies utilize specialized structural geometry for combining water and carbon dioxide or microporous materials to enhance the mixing and/or area of contact therebetween are also known. However, these approaches, while meeting the size constraints of small fountain systems, have not found any real success or acceptance in the marketplace, as the level of carbonation provided thereby is generally too low for commercial purposes. Accordingly, it would be desirable to find an on-demand carbonating system that meets the size criteria of fountain beverage dispensers and that delivers desired levels of carbonation.

A further problem in the beverage dispense industry concerns carbonated pre-mix beverages. Pre-mix beverage is produced at a bottling facility wherein pre-mix tanks are filled with the finished beverage, in much the same manner as are individual serving-sized bottles and cans. The tanks are then transported to the location where needed, often for a temporary facility at an event such as a sporting game or county fair. At the dispense location, the tanks are connected to a pressurized source of carbon dioxide that serves to drive the beverage from the tank, through a cooling device and ultimately into a cup or other receptacle. A main advantage of pre-mix, as opposed to bottles and cans, is that the pre-mix tank is much more efficient in terms of size and ease of handling than would be an equivalent volume of beverage held in a large number such smaller serving containers. Also, once opened, the contents of a bottle or can must be used at that time, as the carbonation is lost rapidly, and as there would be no practical way of insuring or preserving the sanitary condition thereof. However, pre-mix tanks must be fairly robust in that they are required to safely contain the pressure inherent in the beverage itself as well as the dispense pressure. In addition, they must endure the rigors of transport, sterilizing and reuse. Also, they must not affect the quality or flavour of the pre-mix beverage, which beverage can be quite corrosive. As a result of the foregoing, pre-mix tanks are made of stainless steel, which is one of the main factors contributing to the relatively high cost thereof. Accordingly, it would be desirable to have a system for pre-mix dispensing that can utilize a far less expensive container.

An additional problem with current pre-mix systems concerns the further uptake of carbon dioxide into the beverage that can occur during any long periods of non-dispense, such as over night. This over carbonating situation results in the undesirable production of excess foam upon dispensing of the beverage. The over carbonating is of course due to the fact that carbon dioxide gas is used, as referred to above, for the driving dispensing force. Thus, the pre-mix tank functions in the manner of a carbonator tank wherein the pre-mix absorbs the pressurized carbon dioxide gas present therein. Other relatively inert gases, such as nitrogen, could be used for the purpose of driving the beverage, however the bacteriostatic properties afforded by the carbon dioxide gas would then be lost. Accordingly, it would also be desirable to have a pre-mix system that is not susceptible to over carbonating of the beverage, but that does not compromise the resistance to biological contamination thereof afforded by carbon dioxide gas.

The present invention concerns an improved water carbonation system and an improved system for dispensing pre-mix carbonated beverages. The present invention uses a source of pressurized carbon dioxide gas connected to a gas line having a flow restriction means such as a small orifice or needle valve therein, which is in turn fluidly connected to a solenoid valve. In one aspect of the invention, the pressurized gas line then extends from the solenoid valve to a T-fitting. A pump is connected to a source of potable water and serves to pump the water along a water line to the T-fitting. A carbonated water line extends from the T-fitting and flows to a turbulating means. The line then extends from the turbulating means to a heat exchange coil of a beverage dispensing machine and ultimately to a dispensing valve.

In operation, the flow restricting means delivers a predetermined volume of carbon dioxide gas to the T-fitting at a predetermined pressure. The pump is set at a flow rate to deliver a predetermined volume of water to the T-fitting at a predetermined pressure lower than that of the gas. Both flow rates are calculated to produce carbonated water of a particular desired carbonation level. Thus, the carbon dioxide gas and water are initially mixed at the T-fitting and flow therefrom along the carbonated water line. As the carbon dioxide gas and water flow there along, the gas is absorbed into the water and the turbulating means serves to enhance that combination. At the beverage dispenser, the mixture of carbon dioxide gas and carbonated water is cooled, by for example, flow through the serpentine coils of a cold plate, which cooling and flow time through such coils serves to further enhance the formation of carbonated water.

Once the carbonated water has reached a dispensing valve, all of the gas has been absorbed by the water wherein it is then carbonated to the desired level. As a result thereof, a carbonator tank is not required and an on demand supply of carbonated water is provided as determined by, the pre-set flow rates, the effectiveness of the turbulating means and of the cooling ability of the dispenser.

In a related embodiment of the present invention, all of the components are the same as above described, except that the pump is connected to a bag-in-box container having therein a volume of pre-mix beverage. The pre-mix beverage is specialized in that it has been produced at the bottling facility without carbonation, i.e., flat water and syrup have been combined in the desired ratio. Lacking carbonation, it can be held in a bag-in-box container. Then, by use with the system of the present invention, this specialized pre-mix is carbonated in the manner as described above. Thus, the pre-mix beverage is combined only with an amount of carbon dioxide gas that will provide for the desired level of carbonation thereof, assuming full absorption thereof. In this manner, an over carbonating situation is eliminated as there is no excess of carbon dioxide gas present. In addition, a much less expensive bag-in-box system can be used to replace the traditional metal pre-mix tanks.

A better understanding of the structure, function, operation, objects and advantages of the present invention can be had by reference to the following detailed description which refers to the following figures, wherein:

Fig. 1 shows a schematic view of the present invention.
Fig. 2 shows a plan view of a flow restrictor of the present invention.
Fig. 3 shows a cross-sectional plan view of a turbulator.
Fig. 4 shows a cross-sectional view of the turbulator of Fig. 3.
Fig. 5 shows an enlarged plan view of the turbulator of Fig. 3.
Fig. 6 shows a further cross-sectional view of the turbulator of Fig. 3.
Fig. 7 shows a schematic view of an alternate embodiment of the present invention.

A schematic representation of the beverage dispenser system of the present invention is seen in Fig. 1 and generally referred to by the number 10. System 10 includes a cylinder of pressurized carbon dioxide gas 12 having a regulator valve 14 and connected by a pressurized gas line 15 to a check valve 16. A flow restrictor 17 is connected in line 15 and followed by a solenoid valve 20. Various types of flow restrictors are known in the art, such as, cap tubes, flow washers, flow restricting tubes and needle valves. In a preferred embodiment of the present invention, the flow restrictor comprises a flow restricting tube 21, as illustrated in cross-section in Fig. 2. Tube 21 is connected in line 15 and includes two tube attachment ends 21a, a reduced diameter interior portion 21b and a tube abutment disk 21c. As is known in the art, restrictor tubes can be obtained having a wide variety of specific reduced internal diameters. Line 15 then extends from restrictor tube 21 to a T-fitting 23. A line 24 provides for connecting a pump 25 from a source of water to T-fitting 23. A check valve 26 is connected in line 24 between the source of potable water and pump 25.

A line 30 extends from fitting 23 and includes a turbulating section 32. As seen in Fig. 3, a portion of line 30 includes a turbulating structure 34. A turbulator can consist of a wide variety of structures that by their mere presence in a line through which a fluid is flowing, cause the fluid to be mixed or agitated as it flows into and collides with the various surfaces thereof. Turbulator 34 is well known in the art and comprises a lexan plastic molding that includes a plurality of angularly positioned surfaces 34a and protrusions 34b extending therefrom transverse to the axial extension thereof. These surfaces provide for agitating the water and carbon dioxide as they flow within tube 30 past turbulator 34, i.e., they provide for causing a random turbulent flow as opposed to a more uniform laminar one. Fittings on either end of the turbulation section 32, not shown, or indentations 35 of line 30 at either end of turbulator 34 can serve to retain turbulator 34 in place therein. Those of skill will realize that the turbulator need not be a separate structure from the tube. For example, the tube can include a plurality of surface indentations that intrude into the internal volume thereof thereby causing a desired agitation. Or, various structures, such as rods, can be secured to the tube surface and extend through holes therein into the tube internal flow channel for disrupting the flow therein.

Line 30 extends from turbulating section 32 to a beverage dispensing machine 36. Line 30 then connects to a cooling heat exchange line 38 of dispenser 36. As is known in the art, line 38 is typically bent in a serpentine fashion and extends through an electrically cooled water bath or through a solid ice cooled coldplate. Line 38 is then connected to a beverage dispensing valve 40. Valve 40 is of the solenoid operated post-mix type that is operated by a switch that is generally pushed directly, or contacted by operation of a lever arm 42. An electrical control mechanism, not shown, provides for turning on pump 25 and opening solenoid 20 upon activation of the switch of valve 40.

Operation of valve 40 causes the simultaneous opening of solenoid 20 and operating of pump 25. Restriction tube 21 permits a known quantity of carbon dioxide gas to flow there past to fitting 21 as a function of a predetermined pressure, as set by regulator 14. Likewise, a predetermined known quantity of water is pumped to fitting 21 and initially combined with the carbon dioxide gas therein. This mixture flows along line 30 to turbulating means 34. The surfaces 34a thereof serve to mix the flow of carbonated water and free gas to enhance further combination thereof. This absorption also occurs as the mixture flows through the carbonated water line 38 of dispenser 36 wherein cooling thereof takes place. As is known, lower temperatures enhance the ability of water to absorb carbon dioxide gas. After travelling the length of coil 38 and suitably cooling the water, all of the remainder of the metered gas is absorbed therein as it reaches valve 40. The flow rates of the water and gas are calculated so that a desired level of carbonation is reached once all the gas is absorbed. Those of skill will understand that a separate syrup line, not shown, is connected to each post-mix valve 40. Thus, when valve 40 is operated, fully carbonated water is mixed with syrup in the proper ratio to produce a desired beverage. In contrast, it is also understood that where line 38 carries carbonated water, as in embodiment 10, line 38 can be used to serve more than one post-mix valve with carbonated water.

A further embodiment of the present invention is seen in Fig. 4, and generally referred to by the numeral 50, wherein like components are numbered the same as with the previous embodiment. As seen therein, line 24 is connected to a bag-in-box supply 52 of pre-mix beverage instead of a supply of potable water. A bag-in-box system, as is known, includes a rigid outer box 54 made typically of cardboard and an internal liquid retaining flexible plastic bag 56. Bag 56 is acceptically filled at a bottling facility with pre-mix wherein a syrup and highly filtered water are combined in the proper ratio. However, unlike current pre-mix which comprises a fully finished carbonated drink, the present inventions contemplates the use of a specialized pre-mix. This specialized pre-mix would be the same as the current variety in all aspects, except that it would not be carbonated.

A pre-mix valve 58 is used in place of valve 40. Where valve 58 is fully manually operated by movement of a lever arm 60, a different means for signalling pump 21 and valve 18 to operate is required. The lever arm thereof can be used to contact a switch that provides such a signal. Altemately, a pressure sensing switch can be located in line 30 whereby a sensed reduction in pressure therein below a predetermined level causes pump 21 to operate and valve 18 to open when valve 58 is opened, and where pump 21 is turned off and valve 18 closed when a predetermined high pressure is sensed after the closing of valve 58.

In operation, the bag-in-box 52 is connected to line 24 wherein the contents thereof flows therefrom by the operation of pump 21 when valve 58 is opened. Valve 20 is simultaneously opened and the specialized pre-mix is then carbonated to the desired level in the same manner as described above for the potable water. As is known in the art, the ability of the bag thereof to collapse permits pumping out of it's contents without the need to vent to atmosphere. Thus, the potential to contaminate such contents is thereby greatly reduced. In this system, dispenser 46 will often be of the ice cooled variety having a cold plate wherein line 38 will extend in a serpentine fashion there through. In a pre-mix application, those of skill will appreciate that there exists a single and separate line 38 for each pre-mix valve 58 of dispenser 36. It can be appreciated that pre-mix system 50 eliminates the need for an expensive metal pre-mix tank. And eliminates the possibility of over carbonating, as only the needed amount of carbon dioxide gas is combined with the uncarbonated pre-mix wherein no excess of carbon dioxide is used to drive the beverage.

In a preferred embodiment of systems 10 and 50, the restriction tube 21 has an internal restricted diameter of .016 inch and pump 21 is set to provide a flow rate of 2 ounces per second at 90 to 100 PSI. Tube 21 is supplied with a carbon dioxide pressure of 130 pounds pre square inch creating a flow of gas of.3 cubic feet per minute. This volume of specialized pre-mix or water, and gas, when fully combined, result in the desired carbonation level of 3.7 volumes of gas. Line 30 has a diameter of approximately .25 inch and turbulator 34 fits therein and is approximately 8 inches long. Line 38 has an inside diameter of nominally .25 inch and extends approximately 40 feet through a cold plate or water bath. It was found that these particular embodiments permitted a continuous draw of 2 ounces per second having 3.7 volumes of carbonation and a temperature in the desired range of between 34 to 40 degrees Fahrenheit. Thus, these systems achieve essentially 100% absorption of the carbon dioxide gas metered into the liquid carried in line 30, and therefore the amount of gas calculated to be metered into the fluid is equal to the amount of gas retained by the fluid at the desired carbonation level.

Those of skill will readily realize that various modifications can be made in tube lengths and restriction diameters, pressures, flow rates and so forth to achieve different desired levels of carbonation. It was found that if the length of coil 38 was sufficient to cool and maintain the beverage in the desired temperature range of 34-40 degrees Fahrenheit, at a particular constant flow rate along with some turbulation, then there would be adequate time to permit the full absorption of all the carbon dioxide gas as metered into the specialized pre-mix, i. e. a major factor in both systems in determining completeness of carbonation, for a given cooling capacity, is the length of the heat exchange coil. Those of skill will understand that the completeness of carbonation in a post-mix situation is not as critical as that for pre-mix. As long as the water is adequately carbonated, a post-mix valve has the ability to release some excess gas at the nozzle without the excess causing foaming of the dispensed beverage. In a pre-mix application, nonabsorbed gas can more readily result in foaming of the dispensed drink due to the nature of the valve structure, and that the carbonation is breaking out of or agitating the beverage as opposed to escaping primarily from the less viscous water.

Claims

1. A system for introducing carbon dioxide gas into a liquid, comprising:

   a fluid flow restrictor (17) fluidly connectable to a regulated source (12) of pressurized carbon dioxide gas,
   a fluid fitting (23) having a first inlet for fluid connecting to the flow restrictor (17), and a second inlet for permitting fluid connection thereof to a source of the liquid,
   a control device (16) for permitting or stopping flow of carbon dioxide gas from the pressurized source (12) thereof through the flow restrictor (17) and into the fitting (23),
   a pump (25) for pumping the liquid from the source thereof to the fitting,
   a turbulating device (34) having an inlet end fluidly connected to an outlet of the fitting (23) and having an outlet end fluidly connected to a heat exchange cooling coil (38) and the heat exchange cooling coil (38) fluidly connected to a dispensing valve (40).

2. A system as claimed in claim 1 in which the second inlet is connected with a bag-in-box container (52).

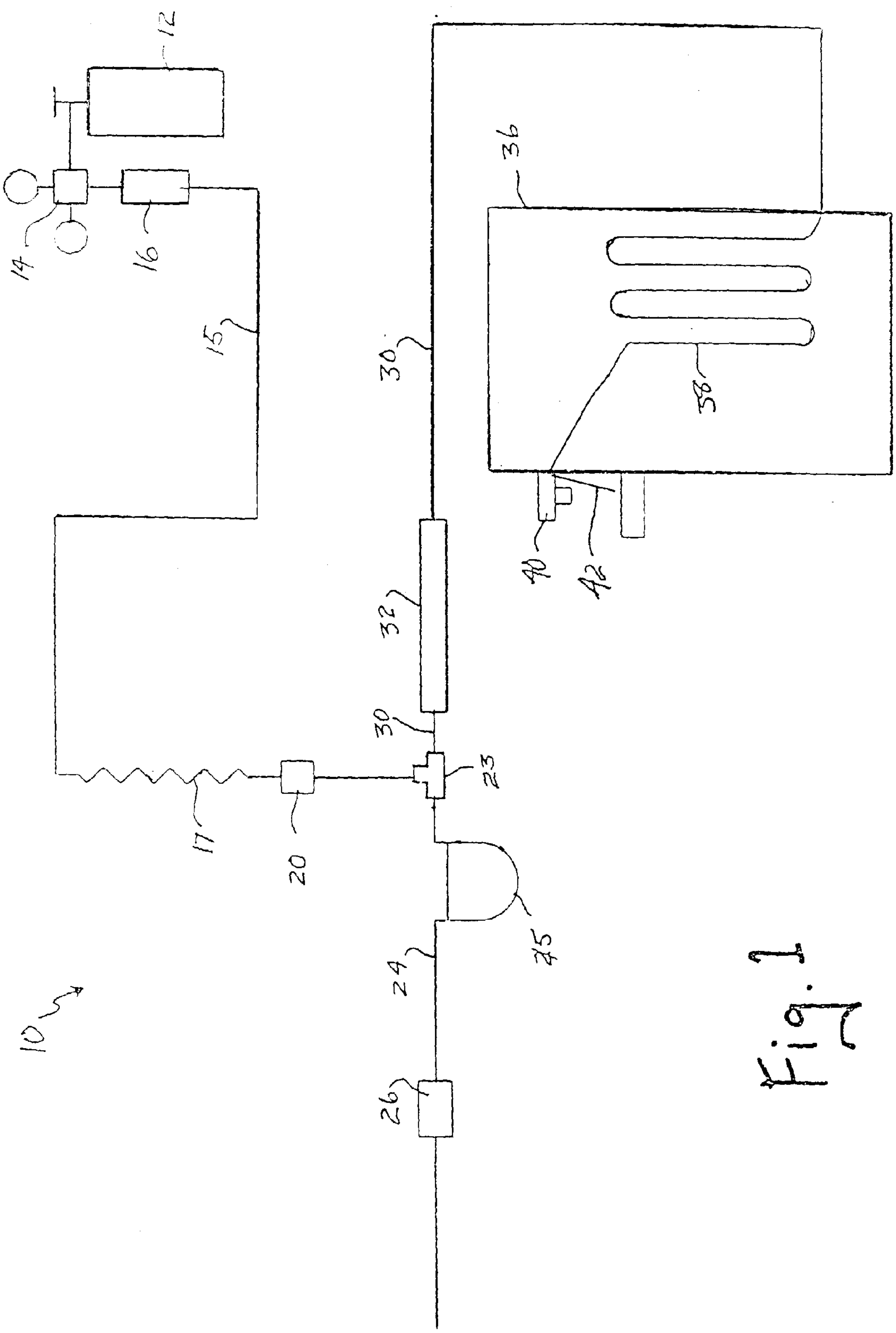

Fig. 1

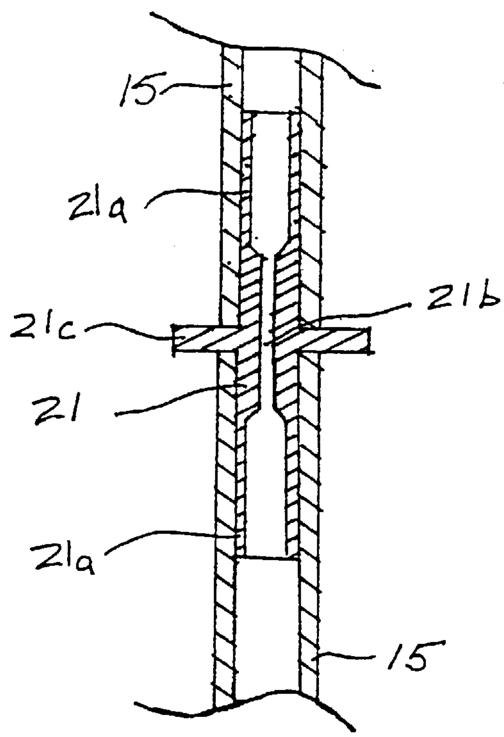

Fig. 2

Fig. 6

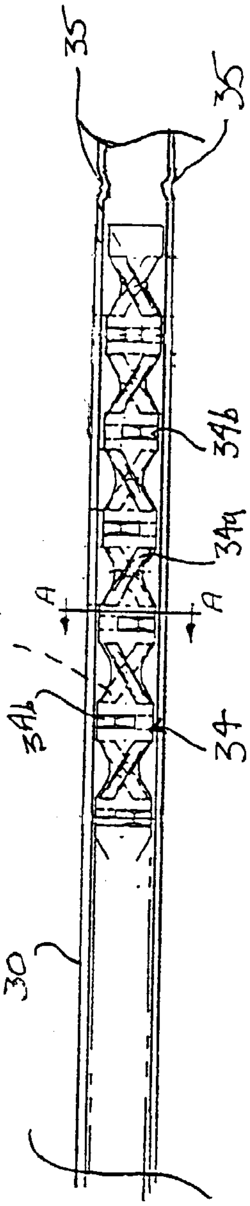

Fig. 3

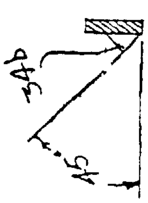

Fig. 4

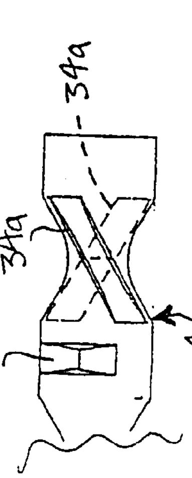

Fig. 5

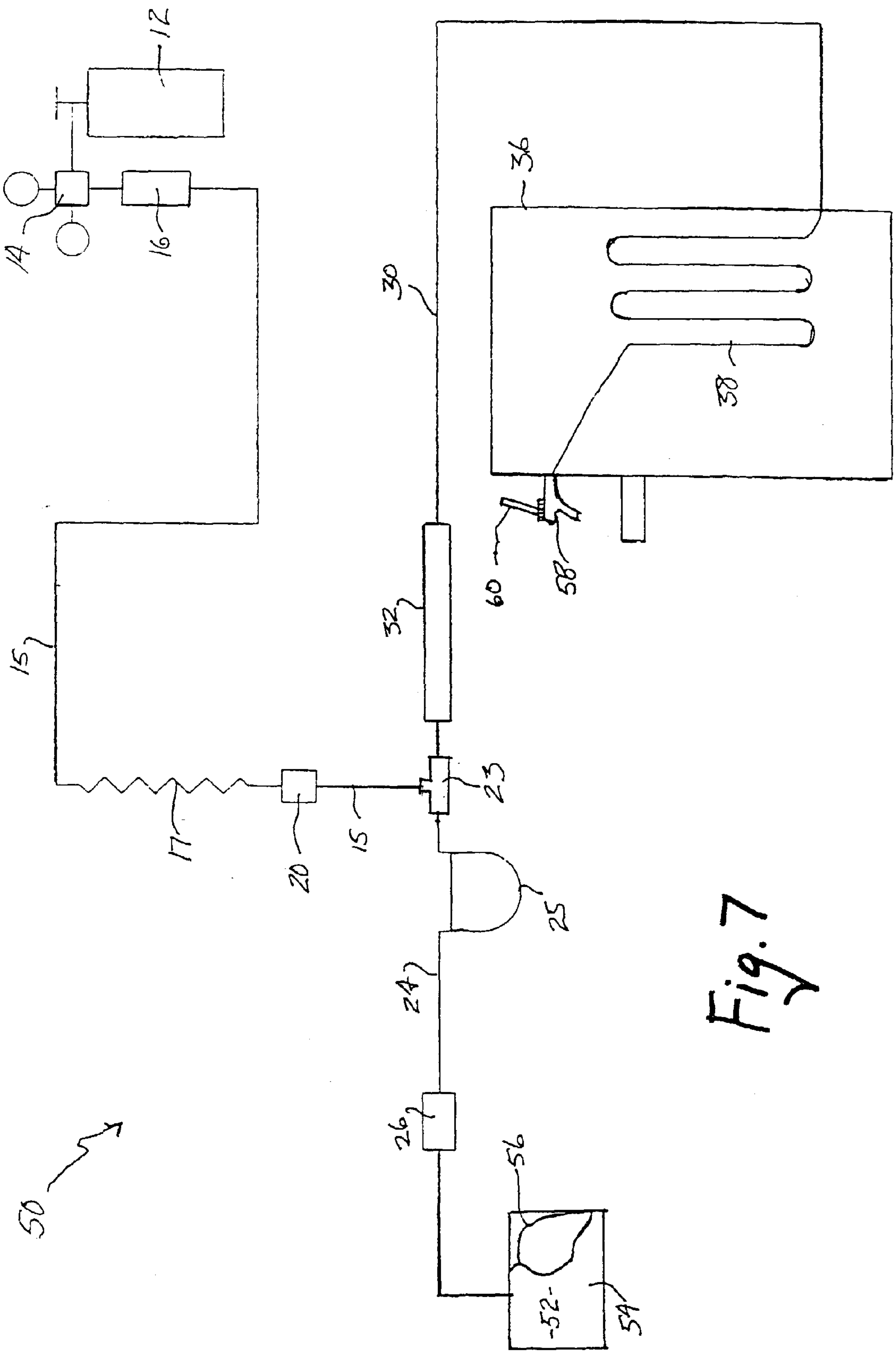

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 98 30 3038

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)
Y	EP 0 195 544 A (GUINNESS SON & CO LTD A) 24 September 1986 * column 4, line 61 - line 65 * * column 5, line 14 - line 15 * * column 5, line 39 - line 41 * * column 5, line 61 - line 64 * * column 6, line 9 - line 12 * * column 6, line 29 - line 36 * * figure *	1,2	B67D1/00 B01F3/04 B01F5/06
Y	GB 1 274 455 A (SCHWEPPES LTD) 17 May 1972 * page 2, line 6 - line 8; figure 1 *	1,2	
Y	DE 296 08 761 U (DUESSELDORF STADTWERKE) 11 July 1996 * page 7 - page 8; figure 1 *	1	
Y	US 2 568 980 A (BAYERS) 25 September 1951 * column 2, line 14 - line 15 *	1	
A	US 3 765 318 A (MAZZA L) 16 October 1973 * column 2, line 6 - line 48; figure 1 *		TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	EP 0 278 773 A (STRENGER ASSOCIATES) 17 August 1988 * figures 14.19 *	1	B67D B01F
A	US 5 510 060 A (KNOLL GEORGE W) 23 April 1996 * figures 1,4 *	1	
A	US 4 898 303 A (LARGE DANNY E ET AL) 6 February 1990 * column 1, line 55 - line 56; figures 1-3 *	1,2	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23 July 1998	Martínez Navarro, A.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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