United States Patent

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[54] **CARBONATOR AND METHOD OF OPERATION THEREOF**
10 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** ..... **261/140 R,** 261/DIG. 7, 261/151
[51] **Int. Cl.** **B01f 3/04**
[50] **Field of Search** ..... 261/140, 151, 130, 155, 68, DIG. 7

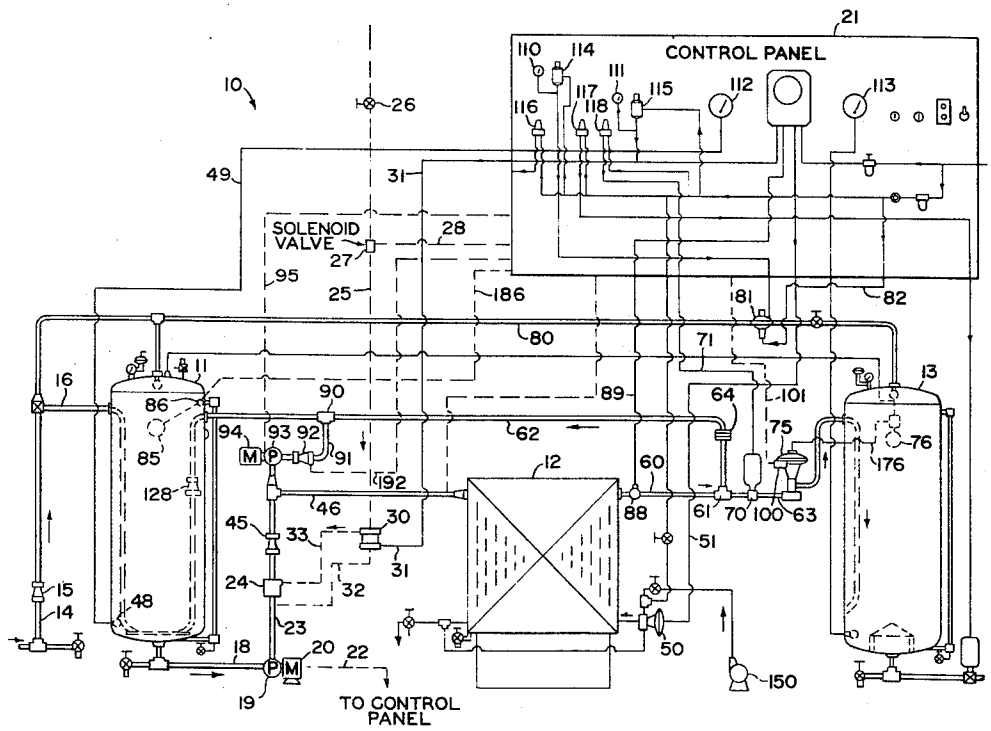
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ABSTRACT: The carbonator system includes first and second beverage vessels with a heat exchanger operatively connected between the vessels with the output of the heat exchanger flowing to the second beverage vessel or receiver. Means provide for pressure flow of beverage to and through the heat exchanger and to the second beverage vessel, carbonation means are present for injection of CO_2 gas under pressure into the beverage prior to its flow to the heat exchanger, and means are present to divert part of the output of beverage from the heat exchanger for return flow to the first beverage vessel. Control means are present to provide the carbonation gas to the system only when beverage is flowing to the second vessel, and in controlled proportion to the rate of flow.



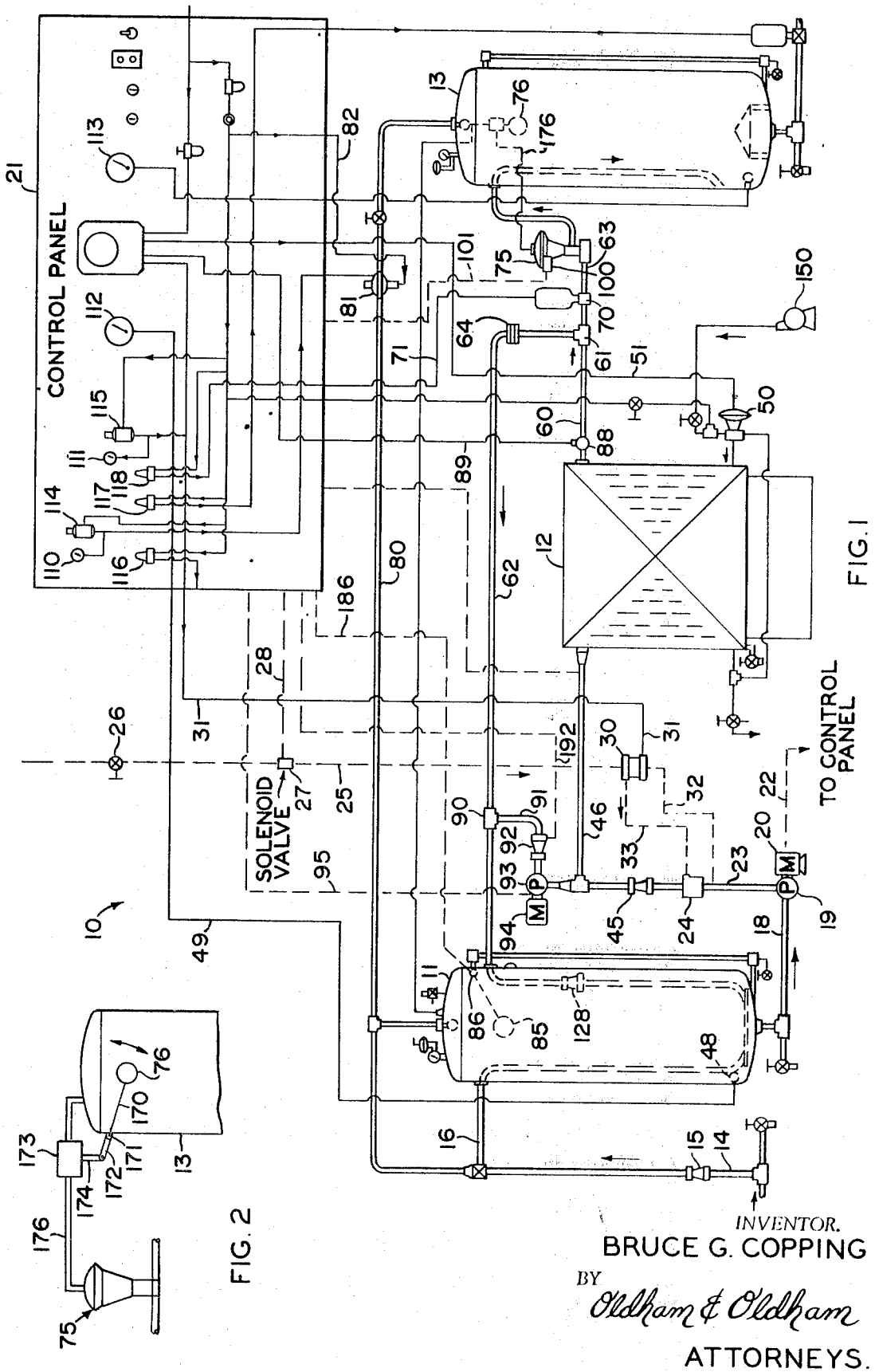


FIG. 1

FIG. 2

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CARBONATOR AND METHOD OF OPERATION THEREOF

BACKGROUND OF INVENTION

In general, the present invention relates to carbonation systems or apparatus, and especially to soft drink beverage carbonation systems.

Heretofore there have been various types of carbonation systems provided for use in the soft drink industry, and most of such systems have been directed to an apparatus for supplying carbonation gas to heat exchanger units wherein the carbon dioxide gas used normally is absorbed in the beverage while it is trickling between or over plates or similar means in the heat exchanger unit provided. Also, the pressure exerted on the beverage may vary in different portions of the system.

In prior carbonation systems, it has been difficult to control, accurately, the amount of carbonation gas absorbed by a liquid as it is being processed. Thus, in some carbonation systems, the degree of carbonation may be dependent upon the pressure or temperature setup in the system, or by the length of time of exposure and it has been difficult to maintain a uniformity of carbonation in the beverages being processed under the variations in operating conditions and pressures that occur in previous types of carbonation system.

The general object of the present invention is to provide a novel and improved carbonation system and apparatus wherein a constant amount of carbonation gas per unit volume of beverage can be injected into the beverage regardless of the system pressure.

Another object of the invention is to provide a constant rate of beverage product flow to a final receiving vessel for the beverage in the system, and to provide for injection of carbon dioxide gas into the beverage only when there is some product flow to the final receiving vessel in the system.

Other objects of the invention include the provision of a novel and improved carbonation system which is readily controllable to set up suitable operating conditions therein from the start of the system; to provide a first and a final beverage-receiving vessel in the carbonation system wherein the pressure on the beverage is equalized in said two beverage-receiving or storing vessels; to provide for a positive rate of injection of a carbonation gas into a beverage independent of the pressure to which the beverage is subjected to during other processing operations; to provide for diversion of a portion of the beverage flowing through a carbonation system for return flow through the carbonation and heat exchanger means of the system to aid in temperature control and to aid in the complete carbonation action for the beverage being processed; to provide suitable means in a carbonation system for circulation of beverage through the heat exchanger means while no beverage is being withdrawn from the system; to simplify and improve the starting of a carbonation system; to provide controlled operating conditions therein; and to provide a carbonation system producing a uniform carbonation of the discharged product.

The foregoing and other objects and advantages of the present invention will be made more apparent as the specification proceeds.

Attention now is directed to the accompanying drawing in which:

FIG. 1 partly diagrammatically shows apparatus embodying the principles of the invention; and

FIG. 2 is a partly diagrammatic detail of a control means in the apparatus.

When referring to corresponding members shown in the drawing and referred to in the specification, corresponding numerals are used to facilitate comparison therebetween.

INVENTIVE DISCLOSURE

The present invention, as one embodiment thereof, comprises first and second beverage-receiving vessels with a heat exchanger operatively connected to and between the vessels so that the output of the heat exchanger flows to the second beverage vessel, means for pressure flow of beverage to and through the heat exchanger to the second beverage vessel, carbonation means for injection of CO_2 gas under pressure into the beverage prior to its flow to the heat exchanger, means for diverting part of the output of the beverage from the heat exchanger to the first beverage vessel, said vessels being connected together for equalizing pressure therein, and control means for supply of CO_2 gas to the carbonation means only when beverage is flowing to the second vessel.

Reference now is particularly made to the details of the structure shown in the drawings. A carbonation system or apparatus is indicated as a whole by the numeral **10**. It includes a first beverage-receiving vessel or tank **11**, a heat exchanger **12**, and a second beverage-receiving and dispensing means or vessel **13**. The beverage to be processed is introduced into the system by a beverage supply line or conduit **14** which normally extends from or connects to the proportioner in the beverage-processing apparatus to which the carbonation system or apparatus **10** is connected. The beverage flows through a check valve **15** in the line **14** with the beverage flowing to and through an input line **16** that extends into the first beverage tank **11** and usually discharges the beverage adjacent the bottom of the tank **11**.

Beverage discharged from the tank **11** flows out through a line **18** to which a suitable driven pump **19** connects for pressure flow of beverage in the system, and to provide for movement of the beverage under suitable operating pressures to and through the heat exchanger **12** to other portions of the carbonation apparatus **10**. A conventional drive motor **20** connects to the pump **19**.

A control panel indicated as a whole by the numeral **21** is provided for the carbonation apparatus and substantially conventional control functions are provided thereby in the apparatus of the invention. Leads **22**, or equivalent, connect from the control panel **21** to the motor **20** to supply power thereto so that the motor **20** is only driven when beverage is flowing through the carbonation apparatus **10** and being discharged from the vessel **13** or when such vessel is not full and beverage will flow thereto. From the pump **19**, a line **23** carries the beverage to and through a carbonation injection means or unit indicated as a whole by the numeral **24**, which usually is an enlarged section, or chamber in the line **23** into which an injection nozzle extends.

A carbonation supply tube or line **25** is provided and it connects to any suitable source of carbonation gas, usually carbon dioxide, and which supply source is not shown in the drawing, with flow through the line **25** being controlled by a shutoff valve **26**. When the system is to operate, naturally the valve **26** is open, and then flow through the line **25** is controlled by a solenoid-actuated control valve **27** which has a lead or leads **28** connecting thereto from the control panel for opening such valve under predetermined operating conditions, as hereinafter explained in more detail. From the control valve **27**, carbon dioxide gas flows to a compound differential pressure control valve indicated as a whole by the numeral **30**. This valve **30** is shown and described in detail in my copending U.S. Pat. application Ser. No. 664,010, filed Aug. 29, 1967 now abandoned. The differential control valve **30** has compressed gas, usually air, supplied thereto through a suitable line or tube **31** connecting to the control panel **21** to provide a controllable pressure and supply of compressed gas to the valve **30** to one face of a differential pressure diaphragm in the valve. The carbon dioxide supply line **25** connects to the opposite side of the differential pressure diaphragm in such valve **30** whereby carbon dioxide is only passed through the valve **30** when its pressure exceeds the pressure of the control gas supplied through the tube **31** plus the beverage pressure (from a pressure-transmitting line **32**). Carbon dioxide gas, when proper operating conditions are established in the differential pressure control valve **20**, then flows therefrom through a line or conduit **33** to the carbonation means **24**. Such carbonation means, in general, comprises an injection unit (not shown) except for the general diagrammatic representation in the draw-

ing so that carbon dioxide gas is injected into the beverage being processed under a predetermined controllable, arbitrary differential pressure between the pressure existing on the beverage being processed prior to carbonation thereof, and the pressure on the carbon dioxide gas, which differential pressure is entirely independent of the pressures existing in the carbonation apparatus for other processing of the beverage or flow of the beverage through the system.

The beverage next flows through a suitable check valve **45** and from such valve through a line **46** connecting to the input of the heat exchanger **12**.

The heat exchanger **12** is of conventional design and normally comprises a plurality of parallel plates having refrigerant flowing between alternate sets of the plates and adapted to have the beverage being processed trickle or flow slowly over the surfaces of the plates having refrigerants on the opposite sides thereof whereby an efficient cooling action is obtained on the beverage as it slowly flows through the heat exchanger **12**. Any suitable source of refrigerant means connects to the heat exchanger **12** for supply of refrigerant thereto as required to maintain the heat exchanger at a predetermined temperature, and any suitable refrigerant such as a water-alcohol solution, can be used in the heat exchanger.

In order to sense the temperature in the beverage being processed under starting conditions, a conventional temperature-sensing means **48** is provided within and adjacent the bottom of the first beverage tank **11** and connects to the control panel **21** by suitable lead or leads **49**. Hence the control panel and conventional means therein can provide for other operations in the apparatus of the invention when proper temperature conditions have been established in the beverage being processed, as hereinafter later described in more detail.

A control valve **50** is provided in the refrigerant flow line and is operatively connected to and controlled through suitable control means in the control panel **21** by lead **51** for flow of refrigerant material to the heat exchanger for maintaining suitable operating conditions therein. Refrigerant is supplied from any conventional source by a driven pump **150** or the like connecting to such supply.

Output from the heat exchanger **12** flows through a line **60** which has a T-coupling **61** therein and a line **62** connecting back to the first beverage tank **11** extends from this coupling **61**. Another flow line **63** connects the coupling **61** to the second beverage tank **13**. The various beverage flow lines are of proper sizes to aid in obtaining balanced flow. So as to control the amount of beverage flowing back to the beverage tank **11** and to have substantially one-half of the beverage being processed returned to such beverage tank for further processing, preferably an orifice plate **64**, or equivalent member, is suitably connected in the line **62** to control return flow of the beverage.

A suitably controlled stop valve **70** is provided in the line **63** and it is controlled, as by a control air pressure, or by electrical means if a solenoid-controlled valve is used, by leads or a line **71** coming from the control panel **21**. A diaphragm valve **75** also is provided in the line **63** and it is controlled by a float **76** provided in the second beverage vessel **13** so that when the float **76** is down, the diaphragm valve **75** is opened and thus calls for, or permits beverage flow to the beverage vessel **13**.

So as to equalize the pressure on the beverage being processed and or being stored in the vessels **11** and **13**, an equalizer tube **80** connects between the tops of the two members, and it normally has a control valve **81** provided therein. By having equalized pressures in the two vessels, whenever a product is flowing to the vessel **13**, the beverage will flow at a constant rate depending upon the resistance to flow of the various pipes and other elements in the system. Since pressure changes in the system will effect equally the suction pressure and the discharge pressure of the pump **19**, the pump will deliver at a constant rate regardless of the absolute pressure within the system. In other words, the pump need not be aware of changes in the absolute pressures existing in the system, but only of the hydraulic resistance to flow. This resistance is constant within a given system.

SYSTEM STARTUP CONDITIONS

In starting the carbonation apparatus **10**, the beverage tank **11** is pumped full of beverage to be processed. Filling of the tank is terminated by means of a float **85** provided in such tank and with the float **85** connecting to a float-controlled valve **86** which in turn is connected to the control panel **21** by lead **186** to terminate the filling action when the float **85** is properly elevated in the tank. The pressure-balancing valve **81** connects to the top of the vessel **11**, as hereinafter described, and it permits air displaced by the incoming product to escape to prevent any excessive buildup of pressures in the tank or vessel. Then, with the stop valve **70** closed, the pump **19** is started to circulate the product through the then nonfunctioning carbonation means **24** and to the heat exchanger **12** and back to the beverage tank **11** through the line **62**. Recirculation of this beverage continues until the temperature of the product in the beverage tank **11** is reduced to approximately 38° to 40° F. When all beverage reaches such temperature, the temperature-sensing device **48** and controls connected thereto, causes the system to automatically begin the next step in the startup procedure.

The carbonation of the product in the beverage-receiving tank **11** is started when the sensing device **48** shows operating beverage temperature to be suitable and opens the solenoid-actuated valve **27** in the carbon dioxide supply line **25** and permits CO_2 to flow to the carbonation means **24** through the differential pressure control valve **30**. The pump **19** continues to run and the stop valve **70** remains closed during such time. Since it is desired to carbonate the beverage in the beverage tank **11** only to approximately the level reached during normal operation, which is about one-half of the final carbonation level, the control circuit provided by the panel **21** includes a timing device (not shown) which limits the duration of this carbonation phase of the startup procedure. The length of such startup carbonation phase is approximately 2 minutes in a typical operation at the end of which period the beverage tank **11** is filled with a cooled, semicarbonated product as it would be during normal operation. Hence, the unit is now ready for productive operation.

SYSTEM OPERATION WHEN FULL BUT NO BEVERAGE DISCHARGED

When the carbonation apparatus **10** is full of beverage being processed, but no beverage is being withdrawn from the beverage tank, then an additional circulatory system is provided to prevent any of the beverage from freezing in the heat exchanger. Thus, a T-coupling **90** is provided in the line **62** and it connects by a line **91** through a control valve **92** to a suitable pump **93** driven by an attached motor **94**. Usually the pump **93** is relatively small and low in capacity in relation to the pump **19**. This pump **93** connects back to the line **46** leading to the heat exchanger **12**. Thus, when beverage output flow terminates in the system, suitable control means represented by a lead **95** connecting to the control panel can be used to start the motor **94**, open the valve **92** by a lead or tube **192** and circulate the beverage through the heat exchanger at a desirable rate to prevent any freezeup of the beverage being processed.

Conventional control means will shut off the motor **94** and close valve **92** when the valve **75** is next opened for beverage flow.

REGULAR OPERATION

Upon completion of the startup cycle described hereinbefore, the timer provided in the control panel **21** opens the air-operated stop valve **70** so the beverage then flows into the then empty vessel **13** as the float **76** is down and such float **76** operatively connects to the valve **75** to open it and permit the flow of beverage to the tank **13**, as hereinafter described. Hence, as beverage is being circulated through the system by the pump **19**, approximately one-half of the beverage being processed will flow through the line **63** into the vessel **13** while

substantially one-half of the beverage will return by the line 62 to the initial beverage-receiving or storing tank 11 for recirculation in the system. The diaphragm pressure or gas pressure controlled valve 75 is provided with an electrical switch 100 that connects to the control panel by a lead 101 which connects through conventional means on the control panel to control operation of the solenoid-actuated carbonation supply control valve 27 and open it when beverage is flowing to the beverage-receiving vessel 13. This permits carbon dioxide gas to be injected into the product stream by the carbonation means 24. When this beverage-receiving vessel 13 is full and not requiring any flow of product thereto, then the switch 100 associated with the control valve 75 will be actuated through the float 76 to close the solenoid-actuated valve 27 and no carbon dioxide will be injected into the system under such condition. Naturally, the beverage flowing through the line or tube 63 to the storage and discharge vessel 13 is fully carbonated so that any of the product that is diverted through the tube 62 back to the tank 11 serves to carbonate, partially, the incoming uncarbonated beverage concurrently flowing into the tank 11. Likewise, the beverage flowing to the beverage tank 11 through the return line 62 will be reduced to a suitable temperature, such as about 38° to 40° F. so that such processed beverage likewise aids in cooling the incoming beverage and at least partially reduces its temperature to that approaching the desired beverage discharge temperature. Or, stated in another way, if the beverage returned to the tank 11 is exactly one-half of that withdrawn therefrom through the pipe 18, the temperature of the beverage in the tank 11 will be at the midpoint between 38° to 40° F. and the temperature of the incoming product.

Inasmuch as the object of the carbonation system 10 of the invention is to inject a predetermined amount of carbon dioxide gas for each gallon of product withdrawn from the system, it is necessary that the rate of flow of the product to the beverage-receiving vessel 13 must be constant whenever such flow occurs, the carbonating gas must be injected only when the product is flowing to the vessel 13, and the rate of carbon dioxide injection must be constant. As indicated hereinbefore, the rate of flow of the product to the beverage-receiving vessel 13 has been made independent of the system pressure as the flow rate is dependent upon the pump capacity and the fixed hydraulic resistance in the system. The control for the carbonation means 25 is so regulated and actuated that carbon dioxide gas is injected at a constant rate only when beverage is flowing to the vessel 13. The pump 19 is independent of pressure changes in the system and it only has to overcome the resistance to hydraulic beverage flow in the system which resistance is constant within the system of the invention. Such pump 19 is actuated and controlled so that when the beverage vessel 13 is full, the valves 75 and 70 are closed and the pump 19 stops. It only restarts when the beverage vessel 13 again calls for product.

When carbonating beverages, normally air is freed from such beverage. FIG. 2 diagrammatically shows a feature of the carbonation apparatus 10 that will automatically bleed off air and/or gas from the system. Float 76 is carried by an arm 170 which is pivotally supported at 171 and which has an extension section 172 extending to a control or bleed valve 173. The control valve is provided in line 176 and has a control pin 174 extending therefrom. The line or tube 176 connects the interior of the vessel 13 and the pressure therein to the pressure-controlled valve 70 to control the same. When the float 76 is raised by beverage in the vessel 13, the extension section 172 releases the control pin 174 to open valve 173 and bleed air and/or gas from the system and cause the pressure-controlled valve 75 to close. But when the float 76 is lowered, the control valve 173 is closed and the system pressure on the diaphragm of the valve 75 causes it to open for beverage flow.

It will be realized that the tanks 11 and 13 are suitably insulated in any known manner and usually these tanks and most of the connecting lines and pipes used in the system are made from stainless steel.

As the beverage is being circulated initially, a temperature-sensing device 88, which is operatively associated with the pipe 60 and is connected to the control panel 21 by the lead 89, senses the temperature of the beverage being circulated and such device controls the flow of the refrigerant to and through the heat exchanger 12 by the control lead 51 connecting the valve 50 to the control panel which correlates measurements taken on the beverage being processed in different portions of the system so as to control the system's startup and/or operating conditions.

In the control panel 21, it will be realized that any conventional type of timer and control means may be provided to operate the carbonation system in a manner described hereinabove. Thus, the various control valves in the apparatus can be solenoid actuated, be controlled pneumatically or electrically or can be otherwise actuated or controlled from the control panel in a conventional manner. For example, some representative parts are shown in this control panel and may comprise pressure gages 110 and 111 and temperature gages 112 and 113. Precision types of pressure regulators are indicated at 114 and 115. Various control switches are also provided in or on the control panel and are operatively connected in the mechanism. Start and stop switches, etc. likewise can be provided on the control panel with the timer means, recorder means, air filter members and the like. Air pilot valves and similar means can be provided connected to the air-actuated valves in the system with certain of such valves being indicated by the numerals 116, 117 and 118. A nonreturn valve 128 may be provided in the line-returning part of the processed beverage to the first beverage storing tank 11.

It should be noted that, as a practical consideration, it is necessary that the pressure in the system be maintained at some level above the saturation pressure for the gases dissolved in the carbonated product. For this purpose, the pressure balance valve 81 is provided in the pressure balance line 80 which is supplied with controlled air pressure through a line or tube 82 connecting to the control panel to apply a controlled air pressure to the system to maintain its pressure at the desired level. This valve functions to add air to the system if the system pressure falls below the desired level and to bleed air or gas off in the event that the system pressure exceeds the desired level (as may occur during initial filling of the system with beverage).

In another embodiment of the invention, the filler bowl or tank of a known bottle filler apparatus may take the place of the vessel 13 in the system. Such filler bowl or vessel will receive the product from the valve 75. The float 76, bleed valve 173 and associated means naturally would still be operably connected to the valve 75 to control it and product flow therethrough. Such filler bowl or vessel would likewise connect to the equalizing pipe 80 to maintain equal pressure with that in the vessel 11. Considering the second beverage-receiving vessel 13 broadly, it may be the rotatable filler bowl of the filler apparatus and be filled to any desired level with the product.

From the foregoing, it will be seen that the novel carbonation system of the invention is adapted to be started from an empty condition readily and to set up, automatically, proper operating conditions therein. The system is adapted to inject a constant amount of carbon dioxide into the beverage being processed with each unit of beverage being processed receiving uniform amounts of carbonation therein. The flow rate of carbonated product to the beverage vessel 13 is constant when any flow thereto occurs and carbon dioxide is injected into the beverage being processed once operating conditions have been established only when beverage is being withdrawn from the system. Thus, it is believed that the objects of the invention have been achieved.

While one complete embodiment of the invention has been disclosed herein, it will be appreciated that modification of this particular embodiment of the invention may be resorted to without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. A beverage carbonation apparatus comprising
a beverage vessel,
a heat exchanger,
a second beverage vessel,
first means connecting said first beverage vessel to said heat exchanger for beverage flow therebetween,
a pump connecting to said first means for pressure flow of beverage to said heat exchanger,
second means connecting the output of said heat exchanger to said means operatively connected to said first means for injection of CO_2 under a controllable differential pressure into the beverage,
said second beverage vessel for beverage flow thereto,
means connecting said vessels together to equalize the pressure therein, and
means controlling said pump to actuate it only when said second beverage vessel is not full of beverage to a desired level.

2. A beverage carbonation apparatus as in claim 1 and comprising
means for diverting part of the output of said heat exchanger to said first beverage vessel, and
control means to supply CO_2 gas to said carbonation means only when said pump is actuated and delivery of beverage is being made to said second beverage vessel.

3. A beverage-processing and carbonating apparatus as in claim 1 where said second beverage vessel comprises a filler bowl of a bottle1-filling apparatus.

4. A beverage carbonation apparatus as in claim 1 and where said second means comprises
float means operatively positioned in said second beverage vessel, and
gas pressure control valve means operatively connecting to said float means to control flow of beverage to said second beverage vessel when more beverage is required therein.

5. A beverage carbonation apparatus as in claim 4 and comprising
a bleeder valve means operatively connecting to said control valve means and to said float means and receiving the vessel pressure to bleed gas therefrom when said second beverage vessel requires more beverage therein.

6. A beverage carbonation apparatus comprising
a first and a second closed beverage vessel,
a heat exchanger operatively connecting to said beverage vessels with the output of said heat exchanger flowing to said second beverage vessel.
means for pressure flow of beverage to and through said heat exchanger to said second beverage vessel,
carbonation means for injection of CO_2 under pressure at a uniform rate into the beverage prior to its flow to said heat exchanger,
means for diverting part of the output of beverage from said heat exchanger to said first beverage vessel and to maintain pressure thereon when in such vessel, and
control means to supply CO_2 gas to said carbonation means only when beverage is flowing to the second vessel.

7. A beverage carbonation apparatus as in claim 6 and comprising a pressured closed circulatory system including
said first and second beverage vessels and said heat exchanger, and
said carbonation means being constructed and operative to inject CO_2 under pressure into the beverage at a controllable pressure differential independent of the pressure in the system.

8. A beverage carbonation apparatus as in claim 7 and including recirculation means connected around said heat exchanger to recirculate beverage therethrough when beverage is not flowing from said heat exchanger to said second beverage vessel.

9. A method of carbonating a beverage comprising the steps of providing first and second beverage storage areas with a carbonating means in series with a cooling means connecting such areas,
maintaining uniform pressures on the beverage in the two storage areas provided therefor,
forcing beverage to flow at a constant rate under a pressure differential through the carbonation and the cooling means to the second storage area, beverage being withdrawn at will from the second storage area, and
injecting CO_2 gas into the beverage at a constant rate independent of said uniform pressures when and only when the beverage flows to the second storage area.

10. A method of carbonating a beverage as in claim 9 and including the step of bleeding gas from the second storage area when it is full of beverage.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,612,495 Dated October 12, 1971

Inventor(s) Bruce G. Copping

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 7, Claim 1, cancel lines 9 and 10 and substitute therefor

-- carbonation means operatively connected to said first means --

Column 7, Claim 1, following line 12, insert

-- second means connecting the output of said heat exchanger to --

Column 7, Claim 3, line 28, after "bottle", delete "1"

Signed and sealed this 4th day of April 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

FORM PO-1050 (10-69)

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