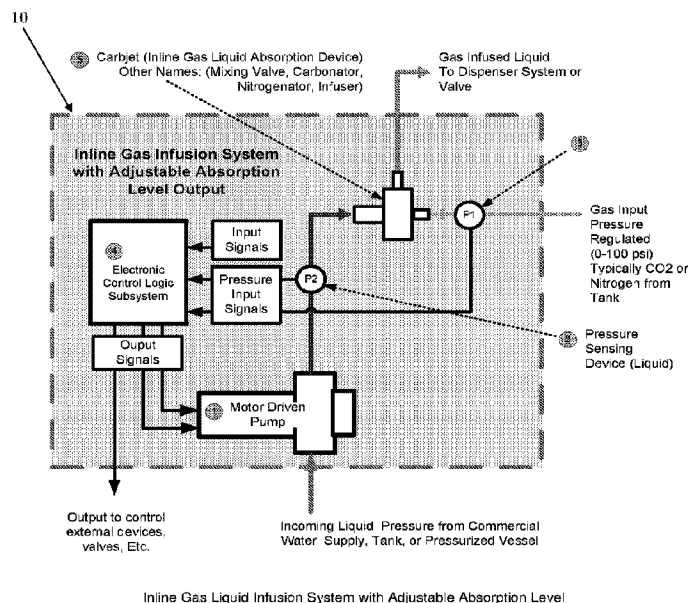




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(57) **Abrégé/Abstract:**

An inline gas/liquid infusion system featuring an electronic control logic and subsystem having a signal processor configured to: receive signaling containing information about a liquid pressure of an incoming liquid provided from a pump to an inline gas liquid absorption device and about a gas pressure of an incoming gas provided to the inline gas liquid absorption device; and determine corresponding signaling containing information to control the liquid pressure of the incoming liquid provided from the pump to the inline gas liquid absorption device in order to provide real time adjustable set point output levels of gas absorption in the inline gas liquid absorption device, based upon the signaling received.

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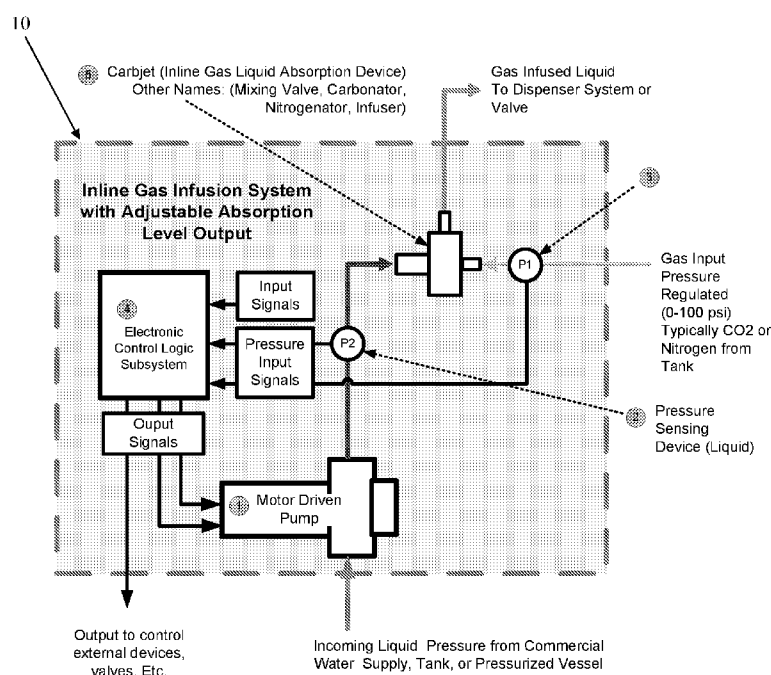


Figure 3: Inline Gas Liquid Infusion System with Adjustable Absorption Level

(57) Abstract: An inline gas/liquid infusion system featuring an electronic control logic and subsystem having a signal processor configured to: receive signaling containing information about a liquid pressure of an incoming liquid provided from a pump to an inline gas liquid absorption device and about a gas pressure of an incoming gas provided to the inline gas liquid absorption device; and determine corresponding signaling containing information to control the liquid pressure of the incoming liquid provided from the pump to the inline gas liquid absorption device in order to provide real time adjustable set point output levels of gas absorption in the inline gas liquid absorption device, based upon the signaling received.

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INLINE GAS/LIQUID INFUSION SYSTEM WITH ADJUSTABLE ABSORPTION OUTPUT AND SELF-TUNING CAPABILITY

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BACKGROUND OF THE INVENTION

1. Field of Invention

The present invention relates to a gas/liquid infusion system for providing a beverage.

10

2. Description of Related Art

Theory of operation: The standard beverage water carbonator is a device designed to dissolve carbon dioxide gas (CO₂) in water, producing carbonated water. CO₂ gas is delivered through a regulator to the carbonator tank gas inlet fitting. Simultaneously, plain water is pumped into the tank from by the vane pump which is fed from a commercial water source. The CO₂ gas, under pressure, dissolves in the water and the result is carbonated water. Some systems include chilling the water before, during, and/or after passing through the carbonator. When the liquid level of carbonated water reaches the liquid level sensing device (inside the tank) upper position probe, the switch opens the circuit and the pump motor turns off. As carbonated water is drawn from the tank, the level of carbonated water will drop. At a certain point, the liquid level switch recognizes the drop in the level and closed the circuit to turns on the pump motor which replenishes the amount of carbonated water that has been taken out of the tank. The output carbonation level produced is constant based on the temperature and pressure conditions of the system.

In typical Soda Beverage Carbonation applications, the liquid inlet pressure to the Carbonator is subject to fluctuations in incoming liquid pressure based on water usage variations in the facility that occurs during the day. It is not possible to maintain the set point or adjust the set point due to the unpredictable nature of the incoming water supply pressure and flow characteristics.

By way of example, see Inline Carbonator Devices, such as that disclosed in U.S. Patent No. 9,033,315 B2, which is assigned to the assignee of the present invention. This device, and similar inline devices, enable mixing of liquid and gas in a flow through an inline mixing chamber as contrasted with the accumulator tank in the first example. The principles of operation are similar to the standard carbonator system, but there is no reservoir tank so the Carbonation of the liquid must happen on demand. The differential pressure between the input gas and liquid streams determines the level of gas absorbed into the liquid at a given temperature. There are different models on the market citing different advantages and performance characteristics, but they do not have the ability to adjust or maintain the set point target in real-time.

The following is a description of some of the shortcomings of the above mentioned devices:

In typical Soda Beverage Carbonator Systems in the market today, the output water carbonation level produced is constant based on the temperature and pressure conditions of the gas liquid system. It is not possible for the end user to adjust carbonation output level of the system either preset or real-time for achieving various desirable end beverage quality characteristics. Additionally, the present systems in the market place lack that ability for real time compensation for typical expected fluctuations in the incoming liquid and gas pressures. This capability is

essential for maintaining target carbonation levels in the presence of unpredictable fluctuations in incoming liquid pressure based on water usage variations throughout the facility that occur during the day.

In the Nitrogen Infusion applications such as Nitrogenized Cold Brewed

5 Coffee or tea, the use of a traditional Tank carbonator system for nitrogen infusion cannot achieve consistent output levels due to the variability in the liquid pressure. The flow and pressure of the liquid to and from the accumulator tank can vary from 20 to 120 PSI when the liquid level in the tank is being replenished; this creates variable flow rate output from the system during dispense and variable nitrogen

10 infusion levels from drink to drink. Furthermore, the accumulator tank does not lend itself to clean in place requirements when used with premixed beverages and can lead to sanitation issues vs. an Inline Infusion Device. These issues and challenges make the use of an inline gas absorption device desirable over existing carbonators with a tank. The challenge with using inline carbonators for this purpose is that the

15 differential pressure required for “inline” nitrogen gas absorption into the liquid is very low; approximately in the range of 0.5 to 3psi differential between incoming gas and liquid under typical system dispenses conditions. This low differential pressure requirement on an inline device poses a big problem because standard regulators and gauges in use in beverage systems today do not have sufficient resolution to

20 adjust the regulator increments fine enough to properly and reliably adjust the set point value. In addition, minor system fluctuations can throw the device out of range of infusion and create non-infused, or largely over infused final drinks. Minor changes can have a big impact on the end drink quality. This prevents the use of existing inline nitrogenizing without the technology presented in this invention.

Challenges for use in Beer Dispense carbonation and/or nitrogen infusion are also based on the variation in incoming liquid pressure to carbonation device, and the complexity of dispense plumbing systems for which a constant flow must be tuned. The pressure to the carbonation device in beer systems is typically a Keg,
5 Cask, or other pressurized vessel requiring gas pressure setting. The keg (vessel) pressure setting in beer dispense varies based primarily on the following:

- The gas input pressure required to achieve the desired liquid output flow rate through the various plumbing systems including tubing, fittings, chiller cold plates in end installations.
- 10 - The keg pressure setting required by differing beer styles in order to achieve the desired carbonation level or nitrogen level in the beer residing in the keg (vessel).
- The Keg pressure settings are also adjusted based on the type of gas being used for infusion and dispense, typically Nitrogen is blended with CO2
15 to allow high pressure to be applied for long distance draft systems without creating over carbonation and foaming from high pressure CO2 alone.

The following are shortcomings of standard beverage dispenser carbonator device (vane pump coupled with a tank):

- The Carbonation level of the liquid output is not user adjustable or
20 real time adjustable
- They are not “self-tuning” and cannot compensate for variation in incoming Liquid or Gas Input Pressures and still maintain target carbonation levels.
- Requires a Tank, and is not Inline type which can be easily cleaned in
25 place

- The tank design is not favorable for Beverages such as soda, coffee, teas, beer, milk based, which requiring clean in place functionality.

- Footprint and size is larger than the Inline Device

5 The following are shortcomings of available Inline Carbonator Devices

- The Carbonation level of the liquid output is not adjustable in real time by means of varying liquid input pressure and flow conditions.

- They cannot compensate for variation in incoming Liquid or Gas Input Pressures and maintain target carbonation levels.

10 In view of this, there is a need in the industry for a better way to carbonate beverages that overcomes the shortcomings of the known beverage carbonation devices.

SUMMARY OF THE INVENTION

15 In summary, the following is description of how the present invention overcomes the above mentioned difficulties:

 The amount of absorption of gas into liquid is a function of the temperature and pressure at which the gas and liquid input streams are being combined. For Inline Carbonator devices the differential pressure between the Gas and Liquid input streams is the critical control parameter for controlling the level of Gas Absorbed into the Liquid at various temperatures. The present invention (Inline variable Gas/Liquid Absorption system) is able to provide real time adjustable set point output levels of gas absorption by monitoring the input pressures and adjusting the liquid input pressure with an electronic controller that executes a control algorithm on the pump and/or other system components. The pump in turn manipulates the pressure of the

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incoming liquid stream in a way that provides a stable and real-time adjustable inlet pressure to the Inline Gas Liquid Absorption device. This is unlike any traditional carbonating (or other gas/liquid absorbing) devices on the market today.

5 Additionally, the system is also able to maintain a consistent target value of gas absorption into liquid in the presence of “inconsistent or variable” incoming system liquid or gas pressures. This novel capability is essential for achieving preset or real-time adjustable gas infusion levels, and maintaining the target set point in the presence of variability in input pressures which are common in standard applications in the market today:

10 The present invention overcomes these application challenges/limitations through the use of pressure sensing devices and a controller with a control algorithm capable of making very precise incremental changes to the pump performance, thereby enabling precise micro adjustments to the differential pressure value for the end goal of precisely maintaining the set point value in the presence of system
15 fluctuations, as well as enabling real time set point manipulation for customizing finished drink characteristics such as carbonation level, nitrogen level, acidity, flavor, mouth-feel, creaminess smoothness, etc.).

Specific Embodiments

20 According to some embodiments, and by way of example, the present invention may include, or take the form of, a new and unique inline gas/liquid infusion system featuring an electronic control logic and subsystem having a signal processor configured to:

 receive signaling containing information about a liquid pressure of an
25 incoming liquid provided from a pump to an inline gas liquid absorption device

and about a gas pressure of an incoming gas provided to the inline gas liquid absorption device; and

5 determine corresponding signaling containing information to control the liquid pressure of the incoming liquid provided from the pump to the inline gas liquid absorption device in order to provide real time adjustable set point output levels of gas absorption in the inline gas liquid absorption device, based upon the signaling received.

By way of example, the system may also include one or more of the following features:

10 The signal processor may be configured to provide the corresponding signaling as output signals to the pump to adjust the liquid pressure of the incoming liquid provided from the pump to the inline gas liquid absorption device, including by varying characteristics of a voltage signal output to the pump.

15 The signaling contains information about the liquid pressure sensed and the gas pressure sensed; and the signal processor may be configured to determine the real time adjustable set point output levels of the gas absorption by monitoring the signaling received and adjusting the liquid pressure of the incoming liquid provided from the pump to the inline gas liquid absorption device based upon a differential pressure between the liquid pressure sensed and the gas pressure sensed.

20 The inline gas/liquid infusion system may include the pump configured to:
 receive the corresponding signaling provided as output signaling from the signal processor, and also receive the incoming liquid; and
 pump the incoming liquid, based upon the output signaling received, ,
 including where the pump is a motor driven pump.

The inline gas/liquid infusion system may include the inline gas liquid absorption device configured to:

5 receive the liquid pressure of the incoming liquid provided from the pump, and the gas pressure of the incoming gas provided from a pressurized gas tank, and

provide a gas infused liquid, including providing the gas infused liquid to a dispenser system or valve.

The signaling may includes liquid pressure input signals, e.g. received from a liquid pressure sensing device configured to sense the liquid pressure of the
10 incoming liquid provided from the pump, and provide the liquid pressure input signals containing information about the liquid pressure of the incoming liquid provided from the pump.

The inline gas/liquid infusion system may include the liquid pressure sensing device.

15 The signaling may include gas pressure input signals, e.g. received from a gas pressure sensing device configured to sense the gas pressure of the incoming gas provided from a pressurized gas tank to the inline gas liquid absorption device, and provide gas pressure input signals containing information about the gas pressure of the incoming gas provided from the pressurized gas tank to the inline
20 gas liquid absorption device.

The inline gas/liquid infusion system may include the gas pressure sensing device.

The pressurized gas tank may be configured to provide CO₂ or nitrogen.

The inline gas liquid absorption device may include, or take the form of, a
25 mixing valve, a carbonator, a nitrogenator or an infuser.

The pump may include, or take the form of, a diaphragm, gear, lobe, flexible impeller, vane or centrifugal pump.

The corresponding signaling may control the pump so as to provide adjusted flow and pressure conditions of the incoming liquid provided to the inline gas liquid
5 absorption device.

The signaling may include at least one feedback signal, e.g., that contains the information about the sensed liquid pressure of the incoming liquid provided from the pump to the inline gas liquid absorption device.

According to some embodiments, the present invention may also take the
10 form of a method, e.g., having steps for

receiving, with a signal processor, signaling containing information about a liquid pressure of an incoming liquid provided from a pump to an inline gas liquid absorption device and about a gas pressure of an incoming gas provided to the inline gas liquid absorption device; and

15 determining, with the signal processor, corresponding signaling containing information to control the liquid pressure of the incoming liquid provided from the pump to the inline gas liquid absorption device in order to provide real time adjustable set point output levels of gas absorption in the inline gas liquid absorption device, based upon the signaling received.

20 The method may also include one or more of the features set forth herein, e.g., including providing the corresponding signaling as control signaling to the pump.

BRIEF DESCRIPTION OF THE DRAWING

The drawing includes Figures 1-6, which are not necessarily drawn to scale,
25 which are briefly described as follows:

Figure 1 shows a standard beverage carbonator that is known in the art.

Figure 2 shows a standard beverage carbonator operation diagram that is known in the art.

Figure 3 shows an inline gas liquid infusion system with an adjustable
5 absorption level, according to some embodiments of the present invention.

Figure 4 shows an example of an application having the inline gas liquid infusion system shown in Figure 3 with an adjustable output, self-tuning application, and also having a single dispenser valve, e.g., for dispensing a nitrogen and/or CO₂ infused coffee, tea, latte, or other drinks, according to some embodiments of the
10 present invention.

Figure 5 shows an example of an application having the inline gas liquid infusion system shown in Figure 3 with an adjustable output, self-tuning application, and also having a single or multiple dispenser valve, e.g., for dispensing a water carbonation to/for beverages like soda, according to some embodiments of the
15 present invention.

Figure 6 shows an electronic control logic subsystem having a signal processor, according to some embodiments of the present invention.

Not every element or arrow in every Figure is labeled with a lead line and reference numeral/label, so as to reduce clutter in the drawing.

20

DETAILED DESCRIPTION OF BEST MODE OF THE INVENTION

The following is a specific description of the operation of the present invention, mentioning all of the components and functions thereof:

Figure 3:

In summary, the present invention provides an Adjustable Inline Gas Infusion System, generally indicated as 10, that operates by infusing gas into a liquid or beverage to a desired amount or end products dispense gasification characteristic level as illustrated in Figure 3. Examples of descriptive gasification levels include:

5 fizzy, foamy, gassy, bubbly, etc.

The adjustable Inline Gas Infusion system 10 consists of the following system elements:

- 1) Motor Driven Pump 1,
- 2) Liquid Pressure Sensing Device 2,
- 10 3) Gas Pressure Sensing Device 3,
- 4) Electronic Control Subsystem 4, and
- 5) Inline Liquid/Gas Absorption Device 5.

In Figure 3, the electronic control logic subsystem 4 is also known herein as a "controller"), and the inline gas liquid absorption device 5 is also known herein as a carbjet. Figure 3 also shows pressure input signals provided from the liquid pressure sensing device 2 and the a gas pressure sensing device 3 to the electronic control logic subsystem 4, and output signals provided from the electronic control logic subsystem 4 to the motor driven pump 1. In addition, Figure 3 shows that the electronic control logic subsystem 4 receives input signals, and that the output
15 signals from the electronic control logic subsystem 4 are also provided as an output to control external devices, valves, etc. Figure 3 shows that the motor driven pump 1 receives incoming liquid pressure, e.g., from a commercial water supply, tank or pressurized vessel; that the gas pressure sensing device 3 receives and senses gas input pressure regulated (e.g., 0-100 PSI) from a tank, which may typically take the
20 form of CO₂ or nitrogen; and that the carbjet 5 receives pumped incoming liquid from
25

the motor driven pump 1 and pressurized gas from the tank (see Figs. 4-5), and provides a gas infused liquid to a dispensing system or valve, e.g., like that shown in relation to Figures 4-5.

The incoming liquid stream pressure and flow that is provided to the inline gas infusion system 10 varies by application as is illustrated in Figure 3. For typical beverage soft drink carbonation applications, the water is provided from the restaurant or store's commercial building water system, e.g., as shown in Figure 5. For Beer, Coffee, Teas and other beverages, the incoming liquid may be provided from a Keg or other pressurized vessel, a bag in box, non-pressurized cask, bucket, or any other liquid containing vessel, e.g., as shown in Figures 4 and 5. Based on these applications, the incoming liquid pressure received by the motor driven pump 1 may be variable or fixed and range from 0-100 psi and up to 3 gallons per minute (GPM). The device can be tuned for a variety of incoming liquid pressure and flow conditions, e.g. beyond those described herein. The input signals provided to the electronic control logic subsystem 4 may contain information about the one or more incoming liquid pressure and flow conditions for programming and tuning the electronic control logic subsystem 4 for any particular application.

The Motor Driven Pump 1: The incoming liquid may be provided to the motor driven pump 1 in Figure 3 via rigid tubing or flexible tubing or hose and fittings used in standard beverage dispense applications and plumbing systems. The motor driven pump 1 functions to manipulate the flow and pressure characteristics of the incoming liquid stream based on electronic communication received from the electronic control logic subsystem or controller 4. The motor driven pump 1 can be any type of pump that is suitable for the liquid and performance desired. Example types may include pumps like Diaphragm, Gear, Lobe, Flexible Impeller, Vane,

Centrifugal, etc. The motor driven pump 1 provides adjusted flow and pressure conditions to the pumped incoming liquid sensed by the liquid pressure sensing device 2 and provided to the carbjet 5 where the liquid is then mixed with gas.

The Liquid Pressure Sensing Device 2: The liquid pressure sensing device 2 functions to provide liquid pressure feedback in the form of an input signal to the Electronic Control Logic Subsystem 4. The liquid pressure sensing device 2 can be a separate device in line, or can be a device that is incorporated as an integral part of the motor driven pump 1, the gas pressure sensing device 3, the electronic control logic subsystem 4, and the carbjet 5 or other external system component. The liquid pressure sensing device 2 may be directly or indirectly sensing the pressure and communicating the feedback through various types of process signal communication values and methods. The fluid is then introduced into the Inline Liquid/Gas Absorption device 5.

The Inline Liquid/Gas Absorption device 5: The inline liquid/gas absorption device 5 in the inline gas infusion system 10 functions to mix the gas and liquid streams for an end result of infusing the gas into the liquid phase. The pressure and flow characteristics of the incoming streams determine the degree of absorption of gas into the liquid at a given temperature, pressure, and flow condition. The gas input is a regulated supply typically provided by Gas storage cylinders and other types of pressurized vessels via properly rated tubing or hose, and fittings, e.g., as shown in Figures 4-5. The gas may consist of one or more types of gas, premixed or fed separately into the carbjet 5. The incoming gas supply flows to the Gas Pressure Sensing Device 3 prior to entering the mixing chamber of the carbjet 5.

The Gas Pressure Sensing Device 3: The gas pressure sensing device 3 functions to provide gas pressure feedback in the form of the pressure input signals

to the Electronic Control Logic Subsystem 4. The Gas Pressure Sensing Device 3 may be a separate device in line, or may be a device that is incorporated as an integral part of the motor driven pump 1, the pressure sensing device 2, the Electronic Control Logic Subsystem 4, the carbjet 5, or other external system component. Item 3 may be directly or indirectly sensing the pressure and communicating the feedback through various types of process signal communication values and methods.

The Electronic Control Logic Subsystem 4: The electronic control logic subsystem 4 functions to receive input communication signaling from the liquid pressure sensing device 2 and the gas pressure sensing device 3, and or other sensors in the system and implement the control logic. The electronic control logic subsystem 4 provides output communication signaling as the output signals to the motor driven pump 1 for purposes of achieving and maintaining the differential pressure between the incoming liquid and gas feed streams for the end intent of maintaining or changing the set point target for Gas Absorption desired in the liquid output. The absorption level set point is achieved by monitoring and maintaining differential pressure between the Gas and Liquid streams at desired levels entering the carbjet 5 by varying the characteristics of the voltage signal output to the motor driven pump 1. The electronic control logic subsystem 4 may receive communication from other sensors of devices in the inline gas infusion system 10, and use the information to implement control action or output communication signaling to the motor driven pump 1, the liquid pressure sensing device 2, the gas pressure sensing device 3, and the carbjet 5, which are internal to the described system, as well as other internal or external components or devices such as valves, switches, relays, displays, lights, etc. as needed to support auxiliary functions and

other system operational objectives. As one skilled in the art would appreciate, suitable control signaling may be implemented between the electronic control logic subsystem 4 and the motor driven pump 1, the liquid pressure sensing device 2, the gas pressure sensing device 3, and the carbjet 5 to implement control action or output communication signaling, e.g., via hardwiring control lines, as well as other techniques known in the art, such as wireless communications. The electronic control logic subsystem 4 may include both electronic hardware components and software program(s), parameters, variables, and logic that are needed to execute the control algorithm and support the operation of the system.

10

Figure 4

Figure 4 shows an example of a first application generally indicated as 20 having the inline gas liquid infusion system shown in Figure 3 with an adjustable output, self-tuning application, and also having a single dispenser valve, e.g., for dispensing a nitrogen and/or CO₂ infused coffee, tea, latte, or other drinks, according to some embodiments of the present invention.

As shown in Figures 3-4, the motor driven pump 1 may receive the incoming liquid pressure (Fig. 3) from a cold brewed coffee pressurized keg K (Fig. 4) that may be receive pressurized gas (e.g., CO₂ and/or nitrogen) from a pressured gas tank T1, as shown. The pressured gas tank T1 may include a gas regulator R1 for pressurizing the liquid vessel or keg K (e.g., about 16 PSI).

As shown in Figures 3-4, the carbjet 5 receives pressured gas from a pressurized gas tank T2 having CO₂ or nitrogen gas. The pressurized gas tank T2 may include a gas regulator R2 for providing a gas regulator pressurizing inline

absorber device gas input (e.g., about 40 PSI), e.g., for regulating the pressure of the gas provided to the carbjet 5.

As shown in Figures 3-4, the carbjet 5 provides the gas infused liquid (Fig. 3) to a dispensing valve DV shown in Figure 4, e.g., for dispensing the nitrogen and/or CO2 infused coffee, tea, latte, or other drinks or beverage B. Advantages of this application, e.g., include adjustable nitrogen level outputs, self-tuning variations in the system conditions, and the ability to maintain accuracy and performance with variable input pressures.

10 Figure 5

Figure 5 shows an example of a second application generally indicated as 30 having the inline gas liquid infusion system shown in Figures 3 and 4 with an adjustable output, self-tuning application, and also having a single or multiple dispenser valve, e.g., for dispensing a water carbonation to/for beverages like soda, according to some embodiments of the present invention.

As shown in Figures 3-5, the motor driven pump 1 may receive the incoming liquid pressure (Fig. 3) from a commercial incoming water pressure fixture F (Fig. 4, as shown). The pressured gas tank T1 may include a gas regulator R1 for pressurizing the liquid vessel or keg K (e.g., about 16 PSI).

20 As shown in Figures 3-5, the carbjet 5 receives pressured gas from a pressurized gas tank T2 having CO2 or nitrogen gas. The pressurized gas tank T2 may include a gas regulator R2 for providing a gas regulator pressurizing inline absorber device gas input (e.g., about 0 to 100 PSI), e.g., for regulating the pressure of the gas provided to the carbjet 5.

As shown in Figures 3-5, the carbjet 5 provides the gas infused liquid (Fig. 3) to a dispensing valve D shown in Figure 5, e.g., for dispensing the nitrogen and/or CO2 infused syrup-based drinks or beverage. The dispenser D receives the syrup/concentrate, e.g., from a combination of a bag-in-box syrup pump 32, a bag-in-box beverage concentrate container 34 and a pressured gas tank T1, as shown. The pressured gas tank T1 may include a gas regulator R1 for pressurizing gas (e.g. typically 65 PSI) to the bag-in-box syrup pump 32 for driving the same. The bag-in-box beverage concentrate container 34 contain the syrup/concentrate being pumped to the dispenser D.

Figure 6:

By way of example, Figure 6 shows an electronic control logic subsystem generally indicated as 10, e.g. having at least one signal processor or signal processor or processing module 12 (hereinafter "signal processor") for implementing the signal processing functionality according to some embodiments of the present invention. In operation, the signal processor 12 may be configured to:

receive signaling containing information about a liquid pressure of an incoming liquid provided from a pump to an inline gas liquid absorption device and about a gas pressure of an incoming gas provided to the inline gas liquid absorption device; and

determine corresponding signaling containing information to control the liquid pressure of the incoming liquid provided from the pump to the inline gas liquid absorption device in order to provide real time adjustable set point output levels of gas absorption in the inline gas liquid absorption device, based upon the signaling received.

By way of further example, the signal processor may be configured to provide the corresponding signaling as output signals or control signaling to control the pump.

The functionality of the signal processor 12 may be implemented using hardware, software, firmware, or a combination thereof. In a typical software implementation, the processor module may include one or more microprocessor-based architectures having a microprocessor, a random access memory (RAM), a read only memory (ROM), input/output devices and control, data and address buses connecting the same, e.g., consistent with that shown in Figure 3, e.g., see element 14. A person skilled in the art would be able to program such a microprocessor-based architecture(s) to perform and implement such signal processing functionality described herein without undue experimentation. The scope of the invention is not intended to be limited to any particular implementation using any such microprocessor-based architecture or technology either now known or later developed in the future.

By way of example, the electronic control logic subsystem 4 may also include, e.g., other signal processor circuits or components 14 that do not form part of the underlying invention, e.g., including input/output modules, one or more memory modules, data, address and control busing architecture, etc. In operation, the signal processor 12 may cooperation and exchange suitable data, address and control signaling with the other signal processor circuits or components 14 in order to implement the signal processing functionality according to the present invention. By way of example, the signaling may be received by such an input module, provided along such a data bus and stored in such a memory module for later processing, e.g., by the signal processor 12. After such later processing, processed signaling

resulting from any such determination may be stored in such a memory module, provided from such a memory module along such a data bus to such an output module, then provided from such an output module as the primary control C, e.g., by the at least one signal processor 12.

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Possible Applications:

The possible applications may include the following:

Infusing CO₂ or other Gases such as Nitrogen into liquids for beverages Water , Soda, Beer, Coffee, Tea, Milk and Yogurt Based (See
10 Figures 3 and 4), and/or
Infusing CO₂ or other Gases such as Nitrogen into liquids for increasing the effectiveness of cleaning, sanitizing, etc. for example General Surface Cleaning, Soil extraction, Beverage Line Cleaning, Water Purification.

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The Scope of the Invention

While the invention has been described with reference to an exemplary embodiment, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention.

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In addition, may modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment(s) disclosed herein as the best mode contemplated for carrying out this invention.

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Claims

1. An inline gas/liquid infusion system (10) comprising:
an inline gas liquid absorption device (5), and
a pump (1) for providing incoming liquid to the inline gas liquid absorption device (5), characterized by
a liquid pressure sensing device (2) configured to sense a liquid pressure of the incoming liquid,
a gas pressure sensing device (3) configured to sense a gas pressure of an incoming gas provided to the inline gas liquid absorption device (5), and
an electronic control logic subsystem (4) having a signal processor (12) configured to:
receive from the liquid pressure sensing device (2) signaling containing information about the liquid pressure of the incoming liquid provided from the pump (1) to the inline gas liquid absorption device (5);
receive from the gas pressure sensing device (3) signaling containing information about the gas pressure of the incoming gas provided to the inline gas liquid absorption device (5);
determine corresponding signaling containing information to control the liquid pressure of the incoming liquid provided from the pump (1) to the inline gas liquid absorption device (5), based upon the signaling received from the liquid pressure sensing device (2) and from the gas pressure sensing device (3); and
control the pump (1) based on the determined corresponding signaling in order to provide real time adjustable set point output levels of gas absorption in the inline gas liquid absorption device (5),
wherein the signaling received contains information about the liquid pressure sensed and the gas pressure sensed; and
the signal processor (12) is configured to determine the real time adjustable set point output levels of the gas absorption by monitoring the signaling received and adjusting the liquid pressure of the incoming liquid provided from the pump (1) to the inline gas liquid absorption device (5) based upon a differential pressure between the liquid pressure sensed and the gas pressure sensed.

2. The inline gas/liquid infusion system (10) according to claim 1, wherein the signal processor (12) is configured to provide the corresponding signaling as output signals to the pump (1) to adjust the liquid pressure of the incoming liquid provided from the pump (1) to the inline gas liquid absorption device (5).

3. The inline gas/liquid infusion system (10) according to claim 2, wherein the corresponding signaling is provided to the pump to adjust the liquid pressure by varying characteristics of a voltage signal output to the pump (1).

4. The inline gas/liquid infusion system (10) according to any one of the preceding Claims 1 to 3, wherein the inline gas/liquid infusion system (10) comprises the pump (1) configured to:

receive the corresponding signaling provided as output signaling from the signal processor (12), and also receive the incoming liquid; and pump the incoming liquid, based upon the output signaling received.

5. The inline gas/liquid infusion system (10) according to any one of the preceding Claims 1 to 4, wherein the pump is a motor driven pump (1).

6. The inline gas/liquid infusion system (10) according to any one of the preceding Claims 1 to 5, wherein the inline gas/liquid infusion system (10) comprises the inline gas liquid absorption device (5) configured to:

receive the liquid pressure of the incoming liquid provided from the pump (1), and the gas pressure of the incoming gas provided from a pressurized gas tank (T2), and provide a gas infused liquid, including providing the gas infused liquid to a dispenser system or valve (DV; D).

7. The inline gas/liquid infusion system (10) according to any one of the preceding Claims 1 to 6, wherein the signaling includes liquid pressure input signals (P2) received from the liquid pressure sensing device (2) configured to sense the liquid pressure of the incoming liquid provided from the pump (1), and to provide the liquid pressure input

signals (P2) containing information about the liquid pressure of the incoming liquid provided from the pump (1).

8. The inline gas/liquid infusion system (10) according to any one of the preceding Claims 1 to 7, wherein the signaling includes gas pressure input signals (P1) received from the gas pressure sensing device (3) configured to sense the gas pressure of the incoming gas provided from a pressurized gas tank (T2) to the inline gas liquid absorption device (5), and provide the gas pressure input signals containing information about the gas pressure of the incoming gas provided from the pressurized gas tank (T2) to the inline gas liquid absorption device (5).

9. The inline gas/liquid infusion system (10) according to claim 8, wherein the pressurized gas tank (T2) is configured to provide CO₂ or nitrogen, or both.

10. The inline gas/liquid infusion system (10) according to any one of the preceding Claims 1 to 9, wherein the inline gas liquid absorption device (5) includes, or takes the form of, a mixing valve, a carbonator, a nitrogenator or an infuser.

11. The inline gas/liquid infusion system (10) according to any one of the preceding Claims 1 to 10, wherein the pump (1) includes, or takes the form of, a diaphragm, gear, lobe, flexible impeller, vane or centrifugal pump.

12. The inline gas/liquid infusion system (10) according to any one of the preceding Claims 1 to 11, wherein the corresponding signaling controls the pump (1) so as to provide adjusted flow and pressure conditions of the incoming liquid provided to the inline gas liquid absorption device (5).

13. The inline gas/liquid infusion system (10) according to any one of the preceding Claims 1 to 12, wherein the signaling includes at least one feedback signal that contains the information about the liquid pressure of the incoming liquid provided from the pump (1) to the inline gas liquid absorption device (5).

14. A method for an inline gas/liquid infusion in an inline gas/liquid infusion system (10), characterized by:

receiving, with a signal processor (12), signaling containing information about a liquid pressure of an incoming liquid provided from a pump (1) of the inline gas/liquid infusion system (10) to an inline gas liquid absorption device (5) of the inline gas/liquid infusion system (10);

receiving, with a signal processor (12), signaling containing information about a gas pressure of an incoming gas provided to the inline gas liquid absorption device (5);

determining, with the signal processor (12), corresponding signaling containing information to control the liquid pressure of the incoming liquid provided from the pump (1) to the inline gas liquid absorption device (5), based upon the signaling received; and

controlling the pump (1) based on the determined corresponding signaling in order to provide real time adjustable set point output levels of gas absorption in the inline gas liquid absorption device (5),

wherein the signaling containing information about the liquid pressure and the signaling containing information about the gas pressure are sensed by means of pressure sensing devices (2, 3) of the inline gas/liquid infusion system (10); and

the method further comprises determining, with the signal processor (12), the real time adjustable set point output levels of the gas absorption by monitoring the signaling received and adjusting the liquid pressure of the incoming liquid provided from the pump (1) to the inline gas liquid absorption device (5) based upon a differential pressure between the liquid pressure sensed and the gas pressure sensed.

15. The method according to claim 14, wherein the method further comprises providing, with the signal processor (12), the corresponding signaling as output signals to the pump (1) to adjust the liquid pressure of the incoming liquid provided from the pump (1) to the inline gas liquid absorption device (5), including by varying characteristics of a voltage signal output to the pump (1).

16. The method according to claim 14, wherein the method further comprises providing the corresponding signaling to the pump to adjust the liquid pressure by varying characteristics of a voltage signal output to the pump (1).

17. The method according to any one of the preceding Claims 14 to 15, wherein the method further comprises configuring the pump (1) to:
receive the corresponding signaling provided as output signaling from the signal processor (12), and also receive the incoming liquid; and
pump the incoming liquid, based upon the output signaling received.

18. The method according to any one of the preceding Claims 14 to 17, wherein the method further comprises configuring the pump as a motor driven pump (1).

19. The method according to any one of the preceding Claims 14 to 18, wherein the method further comprises configuring the inline gas/liquid infusion system (10) to:
receive the liquid pressure of the incoming liquid provided from the pump (1), and the gas pressure of the incoming gas provided from a pressurized gas tank (T2), and
provide a gas infused liquid, including providing the gas infused liquid to a dispenser system or valve (DV; D).

20. The method according to any one of the preceding Claims 14 to 19, wherein the method further comprises receiving liquid pressure input signals (P2) as the signaling from the liquid pressure sensing device (2) configured to sense the liquid pressure of the incoming liquid provided from the pump (1), and to provide the liquid pressure input signals (P2) containing information about the liquid pressure of the incoming liquid provided from the pump (1).

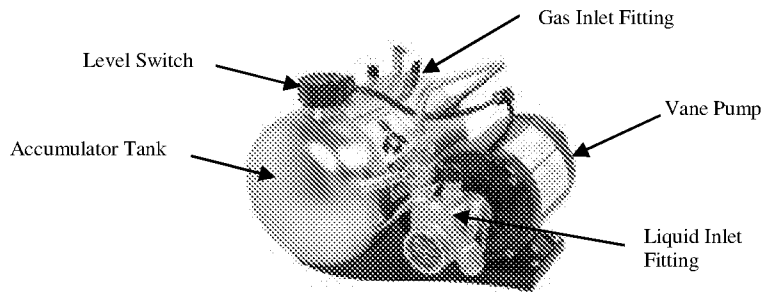


Figure 1: Standard Beverage (Prior art)

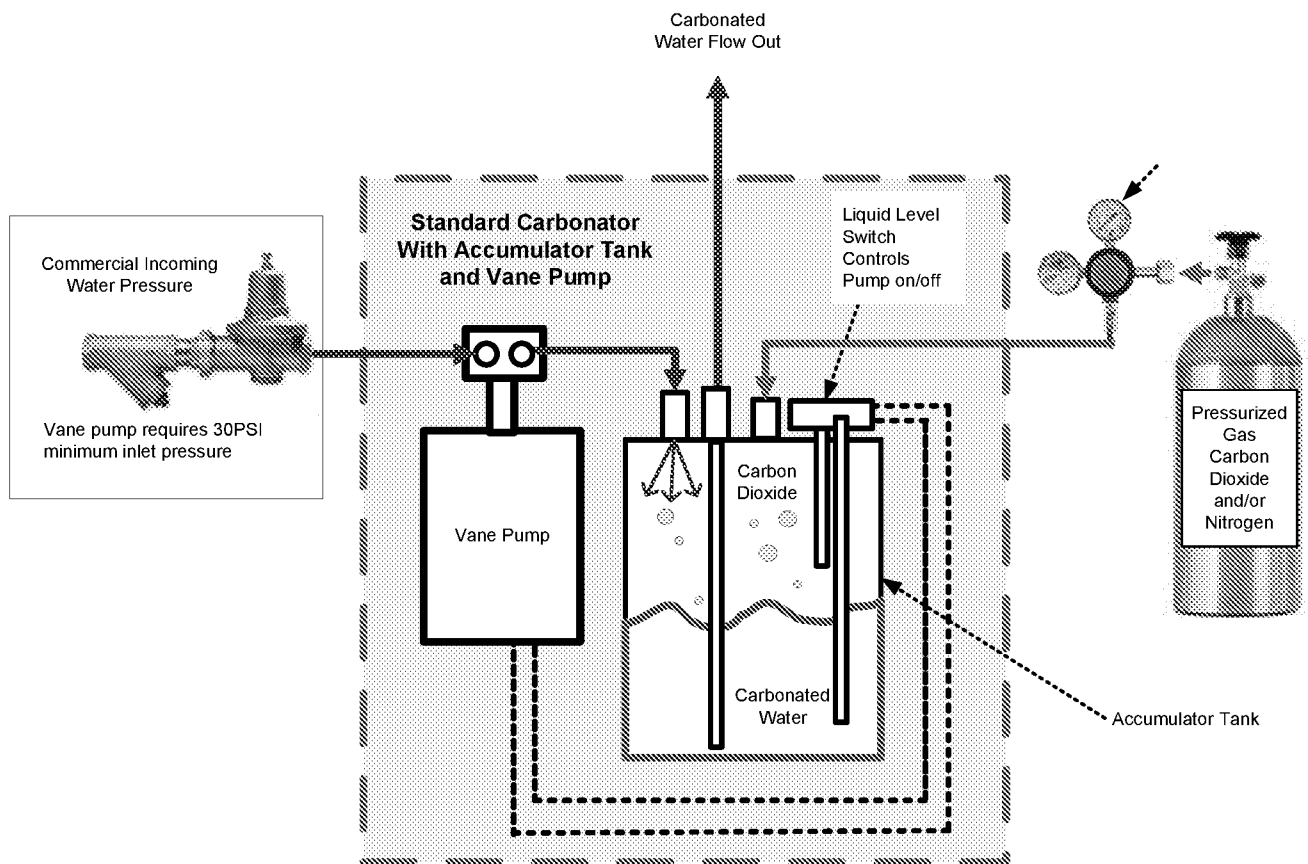


Figure 2: Standard Beverage Carbonator Operation Diagram (Prior art)

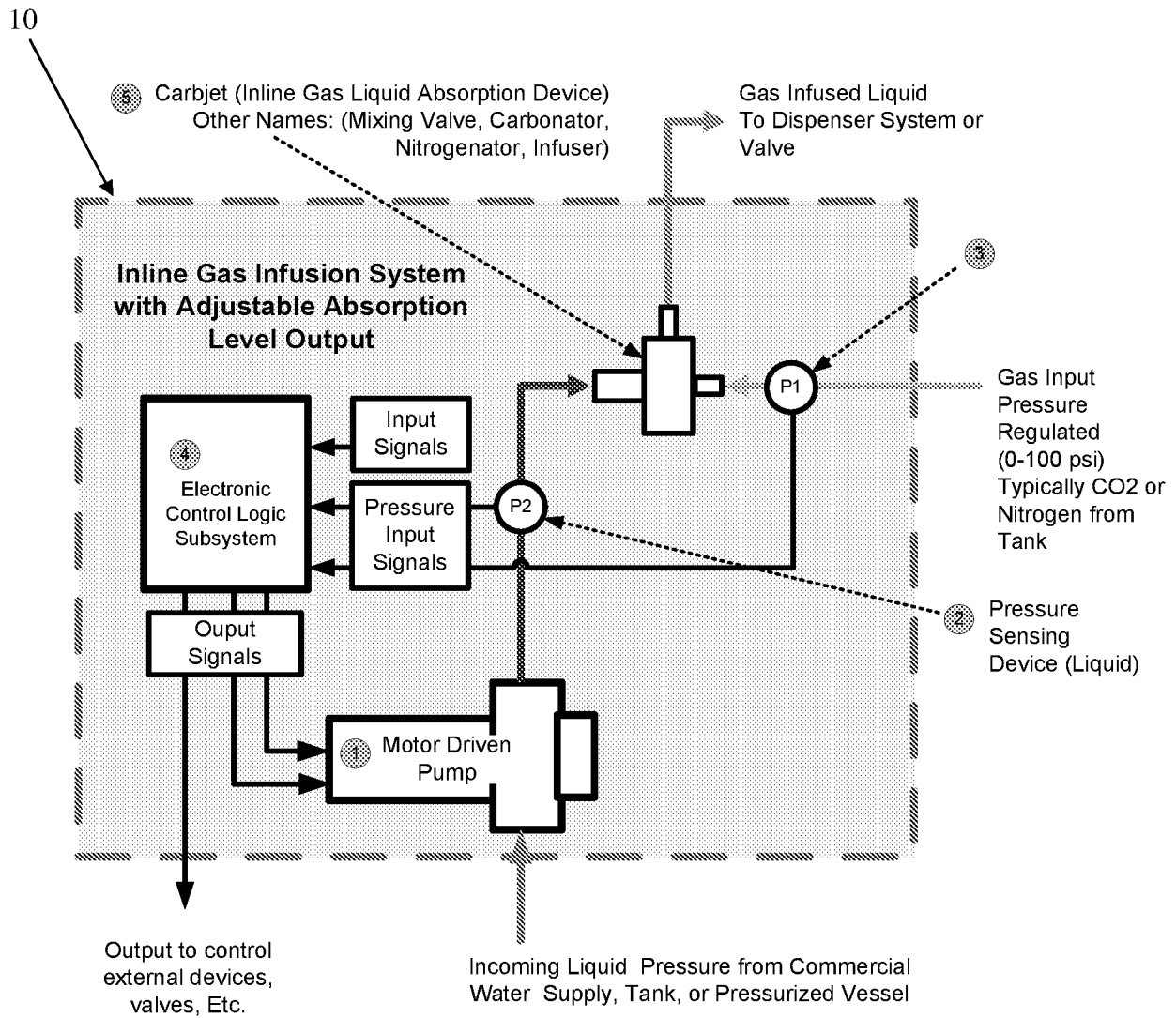


Figure 3: Inline Gas Liquid Infusion System with Adjustable Absorption Level

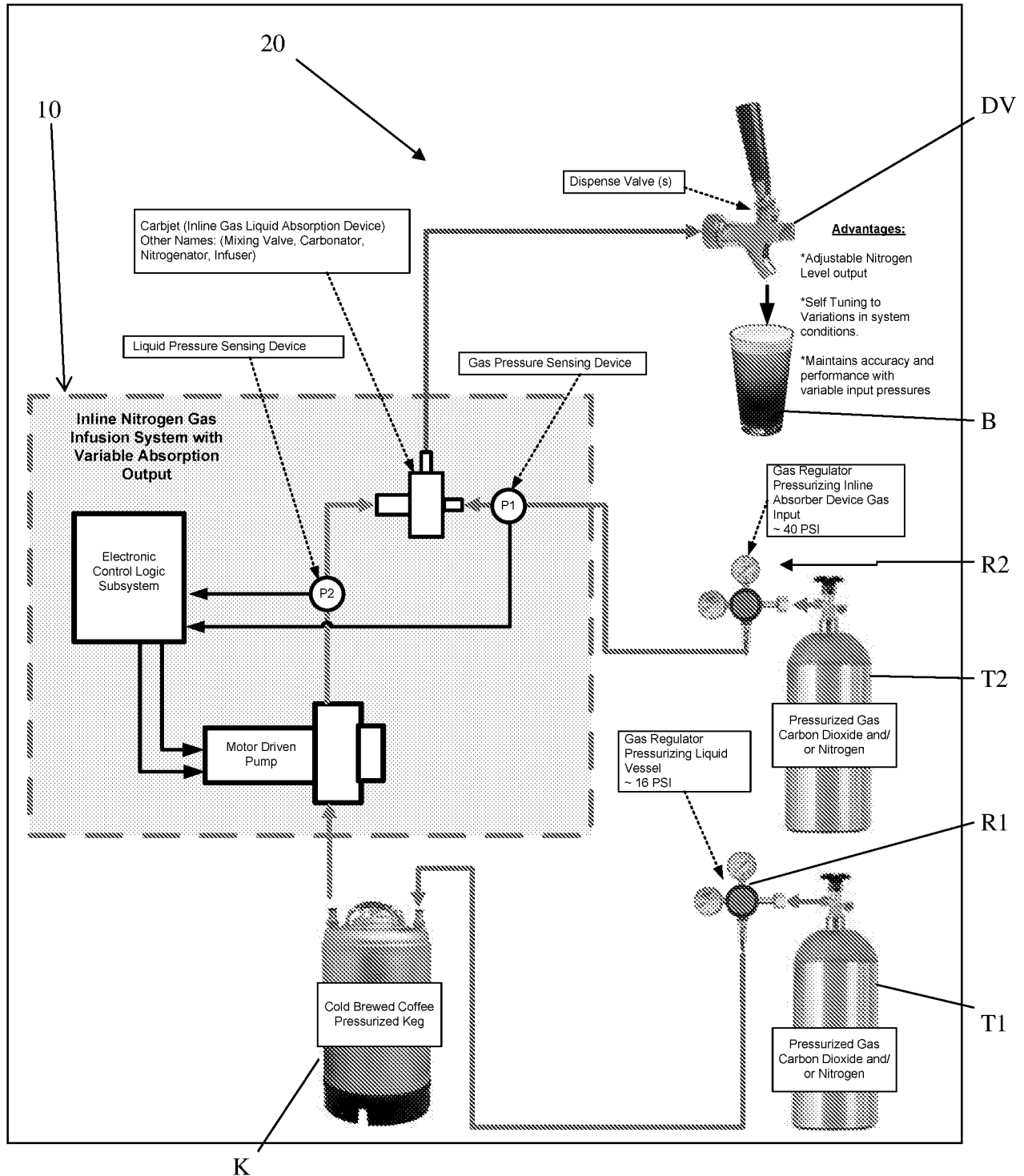


Figure 4 shows an example of an inline gas liquid infusion system with an adjustable output, self-tuning application

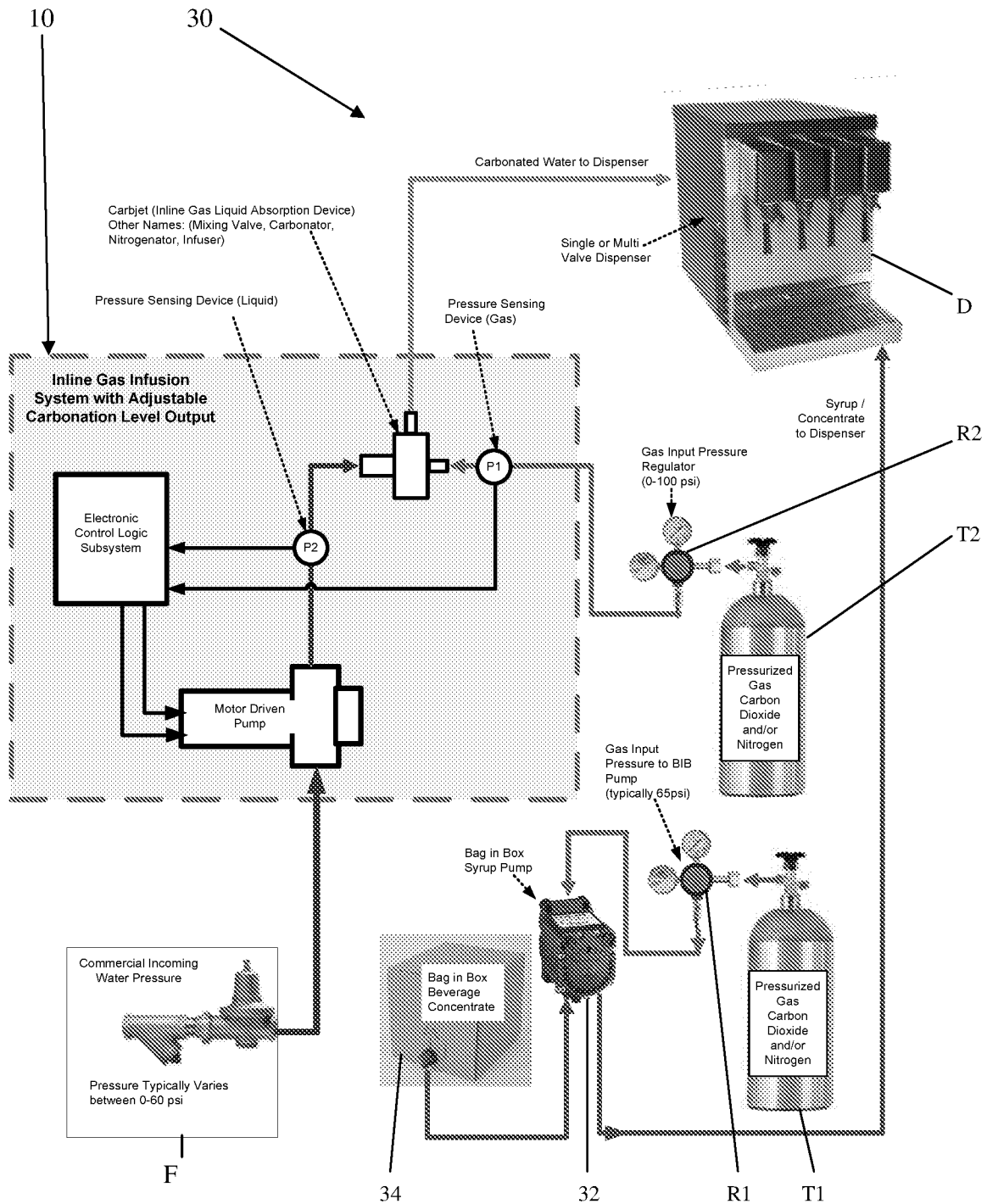


Figure 5 shows an example of an inline gas liquid infusion system with an adjustable output, self-tuning application

A electronic control logic subsystem 4

A signal processor 12 configured at least to:

receive signaling containing information about a liquid pressure of an incoming liquid provided from a pump to an inline gas liquid absorption device and about a gas pressure of an incoming gas provided to the inline gas liquid absorption device;

determine corresponding signaling containing information to control the liquid pressure of the incoming liquid provided from the pump to the inline gas liquid absorption device in order to provide real time adjustable set point output levels of gas absorption in the inline gas liquid absorption device, based upon the signaling received; and/or

provide the corresponding signaling as output signals or control signaling to the pump.

Other signal processor circuits or components 14 that do not form part of the underlying invention, e.g., including input/output modules, one or more memory modules, data, address and control busing architecture, etc.

Figure 6: An electronic control logic subsystem 4

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Carbjet (Inline Gas Liquid Absorption Device)
Other Names: (Mixing Valve, Carbonator,
Nitrogenator, Infuser)

Gas Infused Liquid
To Dispenser System or
Valve

**Inline Gas Infusion System
with Adjustable Absorption
Level Output**

Electronic
Control Logic
Subsystem

Input
Signals

Pressure
Input
Signals

Output
Signals

Motor Driven
Pump

P1

Gas Input
Pressure
Regulated
(0-100 psi)
Typically CO₂ or
Nitrogen from
Tank

Pressure
Sensing
Device (Liquid)

Output to control
external devices,
valves, Etc.

Incoming Liquid Pressure from Commercial
Water Supply, Tank, or Pressurized Vessel

Inline Gas Liquid Infusion System with Adjustable Absorption Level