

A MIXING SYSTEM

Field of the Invention

5 This invention relates in general to a mixing system for mixing a liquid and a gas, and in particular to a mixing system for controlled mixing of a liquid such as de-ionised (DI) water and a gas such as carbon dioxide.

Background of the Invention

10 Semiconductor integrated circuits (ICs) or dies are fabricated on a semiconductor wafer. During the process of packaging the semiconductor dies, the semiconductor wafer is washed with ultra pure de-ionised (DI) water and the dies on the wafer are singulated with a dicing saw. During
15 the dicing operation, DI water is again used as a cleansing agent. When a jet of DI water having a high resistivity i.e. higher than 1 megaohm per centimetre ($M\Omega/cm$), is applied under high pressure to the semiconductor wafer, an electro-static charge is generated due to the relative movement thereof. The electro-static charge can cause electro-static discharge (ESD)
20 to occur, which can damage the dies on the semiconductor wafer. It has been established that mixing DI water with carbon dioxide lowers the resistivity of DI water, which in turn reduces the risk of causing ESD damage to the dies on the semiconductor wafer. However, when the resistivity of DI water is lowered to less than $0.2 M\Omega/cm$, the DI water
25 becomes acidic. Using acidic DI water on the semiconductor wafer can result in corrosion defects on the semiconductor wafer. Therefore, it is necessary to mix controlled proportions of carbon dioxide and DI water to produce DI water having a resistivity within a required range, i.e. between 0.2 to $1 M\Omega/cm$, prior to using the DI water in semiconductor wafer
30 processes.

 A known method of mixing DI water and carbon dioxide is to use a sealed mixing tank. The mixing tank is coupled to a DI water source via a first pressure valve, and coupled to a carbon dioxide source via a second pressure valve. The first valve is set at a predetermined pressure setting,
35 and the second pressure valve is varied while monitoring the resistivity of the DI water at an outlet of the mixing tank. The second valve is varied until the resistivity of the DI water at the outlet of the mixing tank is within the

required range of resistivity. With this method, when there are variations in pressure at the source of the DI water and/or at the source of the carbon dioxide, these variations can result in uncontrolled mixing of the DI water and the carbon dioxide in the sealed mixing tank. If the resistivity of the uncontrolled mixture is outside the required range of resistivity, then a wafer processed with this mixture can be damaged.

Another known method of mixing DI water and carbon dioxide is to use equipment such as the MEGCON model manufactured by NGK FILTECH, LTD. of Japan. This equipment mixes DI water and carbon dioxide using a control system which has feedback. In this equipment, the resistivity of the mixture of DI water and carbon dioxide at the outlet is monitored, and the pressure at the source of the DI water and the source of the carbon dioxide is regulated. When a variation in the resistivity of the DI water at the outlet is detected, the pressure at the source of the carbon dioxide is changed to bring the resistivity of the mixture at the outlet within the required range of resistivity. However, damage to semiconductor wafers processed with the mixture from such equipment still occurs. This is because when the resistivity of the mixture of DI water and carbon dioxide at the outlet is outside the required range of resistivity i.e. uncontrolled, the flow of the mixture to the semiconductor wafer processes continues for a period of time before the equipment corrects the resistivity of the mixture to return to within the required range. Consequently, during this period of time semiconductor wafers are exposed to a mixture having a resistivity outside the required range and can therefore be damaged.

Hence, there is a need for a mixing system that overcomes or substantially alleviates the problems of the known mixing systems.

Summary of the Invention

Accordingly, in one aspect of the invention, there is provided a mixing system A mixing system comprising: a liquid supply having an outlet for providing liquid at a first pressure; a gas supply having an outlet for providing gas at a predetermined supply pressure; a pressure regulator having an inlet coupled to the outlet of the gas supply, an outlet, and a control input coupled to receive a control signal, the pressure regulator being arranged for receiving the gas from the outlet of the gas supply, for receiving the control signal, and for providing the gas from the outlet at a

second pressure which is controlled by the control signal; a mixing chamber having a first inlet coupled to the outlet of the liquid supply, a second inlet coupled to the outlet of the pressure regulator and an outlet, the mixing chamber being arranged for receiving the liquid at the first
5 pressure from the outlet of the liquid supply, for receiving the gas at the second pressure from the outlet of the pressure regulator, for mixing the liquid and the gas to form a mixture having a detectable resistivity, and for providing the mixture from the outlet of the mixing chamber for use in a semiconductor wafer processing system; a detector having an inlet coupled
10 to the outlet of the mixing chamber, an outlet, and a control output, the detector being arranged for receiving the mixture from the outlet of the mixing chamber, for providing the mixture from the outlet of the detector, for detecting the resistivity of the mixture flowing from the inlet of the detector to the outlet of the detector, for generating a detected resistivity signal having
15 a value which is indicative of the detected resistivity of the mixture, and for providing the detected resistivity signal from the control output; a controller having an input coupled to the control output of the detector and having a first output coupled to the control input of the pressure regulator, the controller being arranged for receiving the detected resistivity signal from
20 the control output of the detector, for comparing the value of the detected resistivity signal received from the control output of the detector with a desired resistivity value, for generating the control signal, and for providing the control signal to the control input of the pressure regulator, wherein the controller generates the control signal that causes the pressure regulator to
25 change the second pressure of the gas provided to the mixing chamber so that the value of the detected resistivity signal received by the controller from the control output of the detector becomes substantially similar to the desired resistivity value; and a shut-off valve having an inlet coupled to the outlet of the detector, an outlet coupled to an inlet of the semiconductor
30 wafer processing system, and a control input coupled to a second output of the controller, the shut-off valve being arranged for receiving the mixture from the outlet of the detector, for providing the mixture from the outlet of the shut-off valve to the inlet of the semiconductor wafer processing system, for receiving an out of limits signal indicating a high state or a low state from
35 the second output of the controller, and for stopping the flow of the mixture from the outlet of the shut-off valve to the inlet of the semiconductor wafer processing system upon receipt of the out of limits signal indicating the high

state or the low state from the controller, wherein the controller generates the out of limits signal indicating the high state from the second output of the controller when the value of the detected resistivity signal received by the controller from the control output of the detector is higher than a
5 predetermined upper limit value, and wherein the controller generates the out of limits signal indicating the low state from the second output of the controller when the value of the detected resistivity signal received by the controller from the control output of the detector is lower than a
predetermined lower limit value.

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Brief Description of the Drawings

One embodiment of a mixing system according to the invention will now be more fully described, by way of example, with reference to the
15 drawings, of which:

FIG. 1 illustrates a functional block diagram of a mixing system; and

FIG. 2 illustrates a flowchart detailing the operation of the mixing
20 system.

Detailed Description of the Drawings

FIG. 1 illustrates a mixing system 100 which includes a de-ionised
25 (DI) water source 105 having an outlet for providing DI water. A water pressure valve 110 has an inlet which is coupled to the outlet of the DI water source 105 and an outlet which is coupled to an inlet of a water pressure gauge 115 and to a first inlet of a mixing chamber 145. The DI water source 105, the water pressure valve 110 and the water pressure
30 gauge 115 form a DI water supply for providing the DI water to the first input of the mixing chamber 145 at a first pressure.

The water pressure valve 110 is used to set the pressure of the DI water flowing to the first inlet of the mixing chamber 145. The water pressure gauge 115 detects and indicates the pressure of the DI water
35 flowing from the outlet of the water pressure valve 110 to the first inlet of the mixing chamber 145. The first pressure is a predetermined pressure which is selected based on various considerations. These considerations can

include the volume of DI water required by a semiconductor wafer processing system, and the maximum flow rate of the DI water through a detector 150 at which the detector 150 can accurately detect the resistivity of the DI water flowing through it. The first pressure is set by adjusting the water pressure valve 110 until the first pressure is indicated on the water pressure gauge 115.

The mixing system 100 also includes a carbon dioxide (CO₂) gas source 130 having an outlet for providing a supply of CO₂ gas. A gas pressure valve 120 has an inlet which is coupled to the outlet of the CO₂ source 130, an outlet which is coupled to an inlet of a gas pressure gauge 125 and to an inlet of a pressure regulator 140. The CO₂ source 130, the gas pressure valve 120 and the gas pressure gauge 125 form a CO₂ gas supply for providing the CO₂ gas at a predetermined supply pressure to the inlet of the pressure regulator 140.

The gas pressure valve 120 is used to set the pressure of the CO₂ gas to the predetermined supply pressure. The gas pressure gauge 125 detects and indicates the pressure of the CO₂ gas flowing from the outlet of the gas pressure valve 120 to the inlet of the pressure regulator 140. The predetermined supply pressure is selected based on various considerations.

These considerations can include the maximum volume of CO₂ gas required to reduce the resistivity of the volume of DI water required by the semiconductor wafer processing system. The predetermined supply pressure is set by adjusting the second pressure valve 120 until the gas pressure gauge 125 indicates the predetermined supply pressure.

The pressure regulator 140 has a control input for receiving a control signal from a first output of a controller 147, and an outlet coupled to a second inlet of the mixing chamber 145. The pressure regulator 140 receives the CO₂ from the outlet of the pressure valve 120 and the control signal from the first output of the controller 147, and adjusts the CO₂ pressure provided from the outlet of the pressure regulator 140 to the second inlet of the mixing chamber 145 according to the control signal received from the first output of the controller 147.

The outlet of the second pressure valve 125 is also coupled to an inlet of a pressure switch 135. The pressure switch 135 has a control output coupled to a control input of a low pressure alarm 137. The pressure switch 135 is set to monitor a predetermined supply pressure of the CO₂ gas from

the outlet of the pressure valve 125. The predetermined supply pressure is the minimum required CO₂ gas pressure applied to the inlet of the pressure regulator 140. When the pressure of the CO₂ gas applied to the inlet of the pressure regulator 140 falls to a pressure which is lower than the minimum
5 required CO₂ gas pressure, the pressure switch 135 generates a low pressure alarm signal. A low pressure alarm 137 has an input coupled to the control output of the pressure switch 135 to receive the low pressure alarm signal.

When the low pressure alarm 137 receives the low pressure alarm
10 signal, the low pressure alarm 137 produces a low pressure alarm indicator for an operator. The low pressure alarm indicator can be a visual indicator or an audible indicator or both a visual indicator and an audible indicator operating together.

The mixing chamber 145 is a sealed chamber so that the contents
15 can be maintained under pressure. The first and second inlets are positioned in the mixing chamber 145 such that the CO₂ provided to the second inlet of the mixing chamber 145 bubbles through the DI water provided to the first inlet of the mixing chamber 145. When the CO₂ is bubbled through the DI water a CO₂-DI water mixture is formed having a
20 detectable resistivity.

The mixing chamber 145 has a outlet which is coupled to provide the mixture to an inlet of a detector 150. The detector 150 has an outlet and a control output. The mixture flows from the inlet to the outlet of the detector
25 145 and provides a detected resistivity signal from the control output. The detected resistivity signal has a value which is indicative of the detected resistivity of the mixture flowing from the inlet to the outlet of the detector 150. The control output of the detector 145 is coupled to the input of the controller 147 to provide the detected resistivity signal to the controller 147. The detector 150 is an in-line sensor that measures the resistivity of the
30 mixture from the outlet of the mixing chamber 145, and provides the measured resistivity of the mixture to the controller 147.

The outlet of the detector 150 is coupled to an inlet of a shut-off valve 155 and to an inlet of a drain valve 160. The shut-off valve 155 is normally open and the drain valve is normally closed. The shut-off valve 155 has an
35 outlet which is coupled to an inlet of a semiconductor wafer processing system (not shown), and a control input which is coupled to a second output of the controller 147. The shut-off valve 155 is normally open, i.e. it allows

the mixture to flow from the inlet to the outlet. However, when the shut-off valve 147 receives an out of limits signal from the second output of the controller 147 indicating either a low state or a high state, the shut-off valve 147 inhibits the flow of the mixture from the inlet to the outlet.

5 The drain valve 160 has an outlet which is coupled to a drain and a control input which is coupled to the second output of the controller 147. The drain valve 160 is normally closed, i.e. it inhibits the mixture from flowing from the inlet of the drain valve 160 to the outlet of the drain valve 160. However, when the drain valve 160 receives the out of limits signal
10 from the second output of the controller 147 indicating either a low state or a high state, the drain valve 160 opens and allows the mixture to flow from the outlet of the drain valve 160 to the drain. Thereby preventing the mixture having an uncontrolled resistivity from flowing to the semiconductor processing system.

15 A high-low alarm 152 has a control input which is coupled to the second output of the controller 147 to receive the out of limits signal from the second output of the controller 147. When the high-low alarm 152 receives the out of limits signal having the high state, this indicates the resistivity of the mixture is higher than a predetermined upper limit value
20 and the high-low alarm produces a high alarm indicator for an operator. Alternatively, when the high-low alarm receives the out of limits signal having the low state, this indicates the resistivity of the mixture is lower than a predetermined lower limit value and the high-low alarm produces a low alarm indicator for the operator.

25 The controller 147 receives the detected resistivity signal from the control output of the detector 150, compares the value of the detected resistivity signal with a desired resistivity value and generates the out of limits signal. The controller 147 does this by calculating the difference between the value of the detected or measured resistivity signal and the
30 desired or set resistivity value.

 The difference between the resistivity values is an analogue voltage that may range in value from 0 volts to 10 volts. The difference signal is a control signal which is provided from the first output of the controller 147 to the control input of the pressure regulator 140. The value of the analogue
35 voltage provided to the pressure regulator 140 determines the size of an opening in the pressure regulator 140 through which the CO₂ flows.

The size of the opening regulates the pressure of the CO₂ provided from the outlet of the pressure regulator 140 to the second inlet of the mixing chamber 145. For example, when the voltage is 0 volt the opening is fully closed, when the voltage is 5 volts the opening is 50 % open, and
5 when the voltage is 10 volts the opening is fully opened. When the detected resistivity signal has a higher value than the desired resistivity value, the control signal to the control input of the pressure regulator 140 causes the opening in the pressure regulator 140 to increase. The larger the opening increases, the greater the gas pressure at which the CO₂ gas is provided to
10 the second inlet of the mixing chamber 145.

It is known that the larger the quantity of CO₂ gas dissolved in the DI water the lower the resistivity of the resultant DI water-CO₂ mixture. Consequently, the resistivity of the mixture at the output of the mixing chamber 145 decreases. Alternatively, when the detected resistivity signal
15 has a lower value than the desired resistivity value, the control signal provided to the pressure regulator 140 from the controller 147 causes the opening in the pressure regulator 140 to decrease. The smaller opening decreases the second pressure of the CO₂ gas to the mixing chamber 145. It is known that the smaller the quantity of CO₂ gas dissolved in the DI water
20 the lower the resistivity of the resultant DI water-CO₂ mixture. Consequently, the resistivity of the mixture provided at the output of the mixing chamber 145 increases.

The controller 147, the pressure regulator 140, the mixing chamber 145, and the detector 150 form a control loop. When the control loop is in
25 equilibrium, the opening of the pressure regulator is such that the resistivity value of the mixture detected by the detector 150 at the output of the mixing chamber 147 is equal to the desired resistivity value.

The operation of the mixing system will now be described with reference to FIGS. 1 and 2. At step 205, the operation starts, and in step
30 210 DI water is provided at the first pressure to the first inlet of the mixing chamber 145. This is accomplished by varying the water pressure valve 110 until the water pressure gauge 115 indicates the first pressure. In step 215 the water pressure valve 120 is varied until the pressure indicated by the water pressure gauge 125 is the predetermined supply pressure. The
35 CO₂ gas is then provided at a second pressure to the second inlet of the mixing chamber 145 by the pressure regulator 140. The second pressure is

determined by the control signal provided to the control input of the pressure regulator 140 from the first output of the controller 147.

5 In step 220 the DI water provided at the first pressure and the CO₂ gas provided at the second pressure are mixed in the mixing chamber 147 to form the DI water-CO₂ gas mixture having a resistivity which is detectable by the detector 150. The mixture is provided from the outlet of the mixing chamber 147 to the inlet of the detector 150. In step 225 the detector 150 detects the resistivity of the mixture and generates the detected resistivity signal.

10 In step 230 the value of the detected resistivity signal is compared with the predetermined upper limit value by the controller 147. In step 235 when the detected resistivity value is higher than the predetermined upper limit value, the controller 147 generates an out of limits signal having the high state. This signal is provided to the shut-off valve 155, the drain valve 15
160, and the high-low alarm 152. In response to receiving the out of limits signal having the high state from the second output of the controller 147, several events occur.

These events include: the shut-off valve 155 which is normally open, closes and stops the flow of the mixture from the outlet of the detector 150 to
20 the semiconductor wafer processing system; the drain valve 160 which is normally closed, opens and diverts the mixture received from the outlet of the detector 150 to the drain; and the controller 147 generates the control signal which is provided to the control input of the pressure regulator 140, which causes the pressure regulator 140 to increase the gas pressure of
25 the CO₂ gas to the second inlet of the mixing chamber 145.

In addition, when the high-low alarm 152 receives the out of limits signal having the high state from the second output of the controller 147, the high-low alarm 152 produces the high alarm indicator for an operator. Until such time when the value of the detected resistivity signal reduces to a
30 value lower than the predetermined upper limit value, the shut-off valve 155 will remain closed, the drain valve 160 will remain opened, and the high alarm will continue to be produced.

In step 240 the value of the detected resistivity signal is compared with the predetermined lower limit value by the controller 147. In step 245
35 when the detected resistivity value is lower than the predetermined lower limit value, the controller 147 generates an out of limits signal having a low state. In addition, the out of limits signal is provided to the shut-off valve

155, the drain valve 160, and the high-low alarm 152, and several events occur.

These events include: the shut-off valve 155 which is normally open closes and stops the flow of the mixture from the outlet of the detector 150 to the semiconductor wafer processing system; the drain valve 160 which is normally closed opens and diverts the mixture received from the outlet of the detector 150 to the drain; and the controller 147 generates the control signal which is provided to the control input of the pressure regulator 140. The control signal causes the pressure regulator 140 to decrease the gas pressure of the CO₂ gas to the second inlet of the mixing chamber 145.

In addition, when the high-low alarm 152 receives the out of limits signal having the low state, the high-low alarm 152 produces the low alarm indicator for an operator. Until such time when the value of the detected resistivity signal increases to a value higher than the predetermined lower limit value, the shut-off valve 155 will remain closed, the drain valve will remain opened, and the low alarm will continue to be produced.

When the value of the detected resistivity signal is higher than the predetermined lower limit value and lower than the predetermined higher limit value, the operation moves to step 250. In step 250, if the shut-off valve 155 is closed and the drain valve 160 is opened, then in step 255 the out of limits signal, if it has been generated, terminates and the shut-off valve 155 is opened, and the drain valve 160 is closed.

However, if in step 250 the shut-off valve 155 is open and the drain valve 160 is close, then the operation goes on to step 260. In step 260, the value of the detected resistivity signal from the control output of the detector 150 is compared with the desired resistivity value by the controller 147. In step 270 when the detected resistivity value is lower than the desired resistivity value than the controller 147 generates the control signal for the pressure regulator 140 that causes the gas pressure of the CO₂ to reduce.

In step 265 the detected value of the resistivity signal from the control output of the detector 150 is compared with the desired resistivity value. In step 275 when the detected resistivity value is higher than the desired resistivity value than the controller 147 generates the control signal for the pressure regulator 140 that causes the second pressure of the CO₂ to increase.

When the value of the detected resistivity signal of the mixture detected by the detector 150 is equal to the desired resistivity value, the

control signal generated by the controller 147 for the pressure regulator 140 remains unchanged.

Thus, the mixing system of the preferred embodiment of the invention utilises a control loop, a shut-off valve and a drain valve to ensure that only
5 a mixture of DI water and CO₂ gas having a desired resistivity value is provided to a semiconductor wafer processing system. When the resistivity of the mixture is outside predetermined resistivity limits, the shut off and drain valves stops the flow of the mixture, and diverts the flow of the mixture having uncontrolled resistivity away from the semiconductor wafer
10 processing system. Hence, the mixing system advantageously prevents a mixture of DI water and CO₂ gas having an uncontrolled resistivity value from being provided to a wafer processing system, thereby preventing damage to wafers processed by the wafer processing system.

In addition, the mixing system employs a pressure switch and
15 various alarms. The pressure switch ensures that the CO₂ supply is provided at a predetermined minimum pressure, and the various alarms provide indications to an operator as to the current control status of the resistivity of the mixture provided from the mixing system.

Hence, the mixing system mixes DI water and CO₂ gas to provide a
20 mixture having a controlled resistivity to a semiconductor wafer processing system, and the mixing system diverts the mixture away from the semiconductor wafer processing system when the resistivity of the mixture is not controlled.



CLAIMS

1. A mixing system comprising:
 - 5 a liquid supply having an outlet for providing liquid at a first pressure;
a gas supply having an outlet for providing gas at a predetermined supply pressure;
 - 10 a pressure regulator having an inlet coupled to the outlet of the gas supply, an outlet, and a control input coupled to receive a control signal, the pressure regulator being arranged for receiving the gas from the outlet of the gas supply, for receiving the control signal, and for providing the gas
15 signal;
 - a mixing chamber having a first inlet coupled to the outlet of the liquid supply, a second inlet coupled to the outlet of the pressure regulator and an outlet, the mixing chamber being arranged for receiving the liquid at
20 the first pressure from the outlet of the liquid supply, for receiving the gas at the second pressure from the outlet of the pressure regulator, for mixing the liquid and the gas to form a mixture having a detectable resistivity, and for providing the mixture from the outlet of the mixing chamber for use in a semiconductor wafer processing system;
 - 25 a detector having an inlet coupled to the outlet of the mixing chamber, an outlet, and a control output, the detector being arranged for receiving the mixture from the outlet of the mixing chamber, for providing the mixture from the outlet of the detector, for detecting the resistivity of the
30 mixture flowing from the inlet of the detector to the outlet of the detector, for generating a detected resistivity signal having a value which is indicative of the detected resistivity of the mixture, and for providing the detected resistivity signal from the control output;
 - 35 a controller having an input coupled to the control output of the detector and having a first output coupled to the control input of the pressure regulator, the controller being arranged for receiving the detected



resistivity signal from the control output of the detector, for comparing the value of the detected resistivity signal received from the control output of the detector with a desired resistivity value, for generating the control signal, and for providing the control signal to the control input of the pressure regulator, wherein the controller generates the control signal that causes the pressure regulator to change the second pressure of the gas provided to the mixing chamber so that the value of the detected resistivity signal received by the controller from the control output of the detector becomes substantially similar to the desired resistivity value; and

a shut-off valve having an inlet coupled to the outlet of the detector, an outlet coupled to an inlet of the semiconductor wafer processing system, and a control input coupled to a second output of the controller, the shut-off valve being arranged for receiving the mixture from the outlet of the detector, for providing the mixture from the outlet of the shut-off valve to the inlet of the semiconductor wafer processing system, for receiving an out of limits signal indicating a high state or a low state from the second output of the controller, and for stopping the flow of the mixture from the outlet of the shut-off valve to the inlet of the semiconductor wafer processing system upon receipt of the out of limits signal indicating the high state or the low state from the controller, wherein the controller generates the out of limits signal indicating the high state from the second output of the controller when the value of the detected resistivity signal received by the controller from the control output of the detector is higher than a predetermined upper limit value, and wherein the controller generates the out of limits signal indicating the low state from the second output of the controller when the value of the detected resistivity signal received by the controller from the control output of the detector is lower than a predetermined lower limit value.

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2. A mixing system according to claim 1 wherein the liquid supply comprises:

a liquid source having an outlet for providing liquid;

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a first pressure valve having an inlet coupled to the outlet of the liquid source and an outlet coupled to the first inlet of the mixing chamber,



the first pressure valve being arranged for receiving the liquid from the liquid source, and for varying the pressure of the liquid provided from the outlet of the first pressure valve to the first inlet of the mixing chamber; and

- 5 a first pressure gauge having an inlet coupled to the outlet of the first pressure valve for receiving the liquid provided from the outlet of the first pressure valve, for determining the pressure of the liquid provided from the outlet of the first pressure valve, and for indicating the pressure of the liquid provided from the outlet of the first pressure valve, wherein the first
10 pressure valve can be varied so that the pressure indicated by the first pressure gauge is substantially equal to the first pressure.

3. A mixing system according to either claim 1 or claim 2, wherein the gas supply comprises:

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 a gas source having an outlet for providing gas;

- a second pressure valve having an inlet coupled to the outlet of the gas source and an outlet coupled to the inlet of the pressure regulator, the
20 second pressure valve being arranged for receiving the gas from the outlet of the gas source, and for varying the pressure of the gas provided from the outlet of the second pressure valve; and

- a second pressure gauge having an inlet coupled to the outlet of the
25 second pressure valve for receiving the gas provided from the outlet of the second pressure valve, for determining the pressure of the gas provided from the outlet of the second pressure valve, and for indicating the pressure of the CO₂ provided from the outlet of the second pressure valve, wherein the second pressure valve is varied so that the pressure indicated by the
30 second pressure gauge is substantially equal to the predetermined supply pressure.

4. A mixing system according to any one of the preceding claims wherein the mixing chamber comprises:

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 a hermetically sealed chamber having the first inlet, the second inlet and the outlet disposed on a first side, the first inlet and the second inlet



extending inwardly from the first side towards a second side opposite the first side such that the gas provided to the second inlet is introduced below the level of the liquid causing the gas to bubble through the liquid to form a mixture, wherein the mixture is provided from the outlet.

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5. A mixing system according to any one of the preceding claims further comprising:

10 a drain valve having an inlet coupled to the outlet of the detector, an outlet coupled to a drain, and a control input coupled to the second output of the controller, the drain valve being arranged for receiving the mixture from the outlet of the detector, for receiving the out of limits signal indicating the high state or the low state from the second output of the controller, and
15 for diverting the flow of the mixture from the outlet of the detector to the drain upon receipt of the out of limits signal from the controller indicating the high state or the low state.

6. A mixing system according to any one of the preceding claims further comprising:

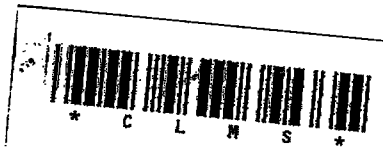
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a high-low alarm having a control input coupled to receive the out of limits signal indicating the high state or the low state from the second output of the controller, for producing a high alarm indicator for an operator when the out of limits signal indicates the high state, and for producing a low
25 alarm indicator for the operator when the out of limits signal indicates the low state.

7. A mixing system according to any one of the preceding claims further comprising:

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a pressure switch having an inlet coupled to the outlet of the gas supply and a control output, for receiving the gas from the outlet of the gas supply, for detecting the pressure from the outlet of the gas supply from the outlet of the gas supply, for generating a low pressure alarm signal when
35 the detected pressure from the outlet of the gas supply is lower than the predetermined supply pressure, and for providing the low pressure alarm signal from the control output; and



a low pressure alarm having a control input coupled to the control output of the pressure switch for receiving the low pressure alarm signal and producing a low pressure alarm indicator for the operator.

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8. A mixing system according to any one of the preceding claims wherein the liquid is de-ionised water.

9. A mixing system according to any one of the preceding claims wherein the gas is carbon dioxide.

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10. A mixing system for mixing de-ionised water and carbon dioxide substantially as described herein with reference to and as illustrated by the accompanying drawings.

