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(54) **FLUORINE GAS GENERATION DEVICE**

(57) A fluorine gas generation device that generates fluorine gas by electrolyzing hydrogen fluoride in molten salt includes an electrolytic cell in which a first gas chamber to which a main product gas having fluorine gas generated by an anode is led and a second gas chamber to which a byproduct gas having hydrogen gas generated by a cathode is led are separated above a liquid level of the molten salt, a raw material supply passage that is

connected to the electrolytic cell to lead the hydrogen fluoride into the molten salt, and a carrier gas supply passage that is connected to the raw material supply passage to lead a carrier gas for leading the hydrogen fluoride into the molten salt to the raw material supply passage, wherein the fluorine gas generated by the anode or the hydrogen gas generated by the cathode is used as the carrier gas.

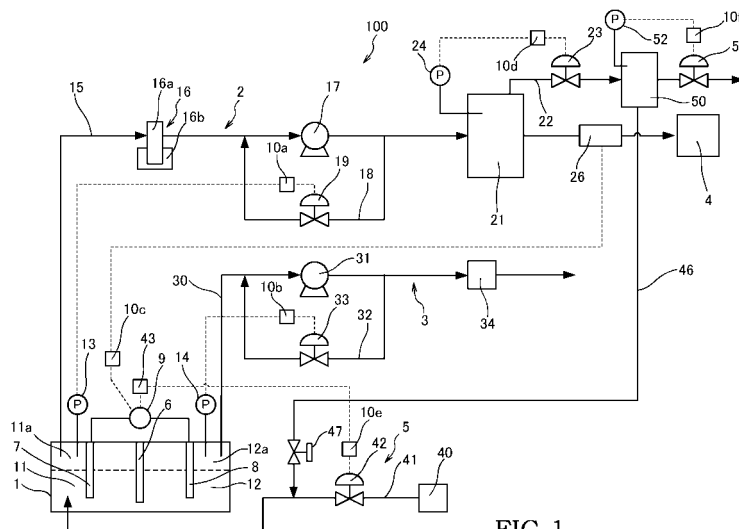


FIG. 1

Description

TECHNICAL FIELD

[0001] This invention relates to a fluorine gas generation device.

BACKGROUND ART

[0002] A device that generates fluorine gas through electrolysis using an electrolytic cell is known as a conventional fluorine gas generation device.

[0003] JP2004-43885A discloses a fluorine gas generation device comprising an electrolytic cell that generates a product gas having fluorine gas as a main component in a first gas phase part on an anode side and generates a byproduct gas having hydrogen gas as a main component in a second gas phase part on a cathode side, and a raw material pipe that supplies hydrogen fluoride serving as a raw material into molten salt in the electrolytic cell.

SUMMARY OF THE INVENTION

[0004] In the fluorine gas generation device described in JP2004-43885A, a carrier gas for leading the hydrogen fluoride into the molten salt in the electrolytic cell is supplied to the raw material pipe for supplying the hydrogen fluoride.

[0005] In the fluorine gas generation device described in JP2004-43885A, nitrogen gas is used as the carrier gas. Therefore, a nitrogen gas supply source is required in addition to a supply source for the raw material hydrogen fluoride, leading to an increase in the scale of the facility.

[0006] Further, the carrier gas must be supplied to the molten salt in the electrolytic cell constantly while the fluorine gas generation device is operative, and therefore a large amount of nitrogen gas is used, leading to an increase in running costs.

[0007] This invention has been designed in consideration of the problem described above, and an object thereof is to provide a fluorine gas generation device capable of reducing running costs with simple facility.

[0008] This invention is a fluorine gas generation device that generates fluorine gas by electrolyzing hydrogen fluoride in molten salt. The fluorine gas generation device comprises an electrolytic cell storing the molten salt, in which a first gas chamber to which a main product gas having fluorine gas generated by an anode submerged in the molten salt as a main component is led and a second gas chamber to which a byproduct gas having hydrogen gas generated by a cathode submerged in the molten salt as a main component is led are separated and defined above a liquid level of the molten salt, a raw material supply passage that is connected to the electrolytic cell to lead the hydrogen fluoride into the molten salt, and a carrier gas supply passage that is con-

nected to the raw material supply passage to lead a carrier gas for leading the hydrogen fluoride into the molten salt to the raw material supply passage, wherein the fluorine gas generated by the anode in the electrolytic cell or the hydrogen gas generated by the cathode in the electrolytic cell is used as the carrier gas.

[0009] According to this invention, either fluorine gas generated in the anode of the electrolytic cell or hydrogen gas generated in the cathode of the electrolytic cell is used as the carrier gas, and therefore the facility can be constructed simply without the need for a dedicated carrier gas supply source. Furthermore, the gas generated by the electrolytic cell is used as the carrier gas rather than a specialized gas, and therefore running costs can be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

FIG. 1 is a system diagram of a fluorine gas generation device according to a first embodiment of this invention.

FIG. 2 is a system diagram of a fluorine gas generation device according to a second embodiment of this invention.

EMBODIMENTS OF THE INVENTION

[0011] Embodiments of this invention will be described below with reference to the drawings.

(First Embodiment)

[0012] Referring to FIG. 1, a fluorine gas generation device 100 according to a first embodiment of this invention will be described.

[0013] The fluorine gas generation device 100 generates fluorine gas through electrolysis and supplies the generated fluorine gas to an external device 4. The external device 4 may be a semiconductor manufacturing device, for example. In this case, the fluorine gas is used as a cleaning gas in a process for manufacturing a semiconductor, for example.

[0014] The fluorine gas generation device 100 includes an electrolytic cell 1 that generates fluorine gas through electrolysis, a fluorine gas supply system 2 that supplies the generated fluorine gas from the electrolytic cell 1 to the external device 4, and a byproduct gas processing system 3 that processes a byproduct gas generated during generation of the fluorine gas.

[0015] First, the electrolytic cell 1 will be described.

[0016] Molten salt containing hydrogen fluoride (HF) is stored in the electrolytic cell 1. In this embodiment, a mixture (KF-2HF) of hydrogen fluoride and potassium fluoride (KF) is used as the molten salt.

[0017] An interior of the electrolytic cell 1 is partitioned into an anode chamber 11 and a cathode chamber 12

by a partition wall 6 submerged in the molten salt. An anode 7 and a cathode 8 are submerged respectively in the molten salt in the anode chamber 11 and the cathode chamber 12. When a current is supplied between the anode 7 and the cathode 8 from a power supply 9, a main product gas having fluorine gas (F_2) as a main component is generated in the anode 7 and a byproduct gas having hydrogen gas (H_2) as a main component is generated in the cathode 8. A carbon electrode is used as the anode 7, and soft iron, monel metal, or nickel is used as the cathode 8.

[0018] A first gas chamber 11a to which the fluorine gas generated by the anode 7 is led and a second gas chamber 12a to which the hydrogen gas generated by the cathode 8 is led are defined above a molten salt liquid level in the electrolytic cell 1 by the partition wall 6 such that gas cannot pass there-between. The first gas chamber 11a and the second gas chamber 12a are completely separated by the partition wall 6, and therefore a reaction caused by intermixing between the fluorine gas and the hydrogen gas is prevented. The molten salt in the anode chamber 11 and the cathode chamber 12, on the other hand, passes under the partition wall 6, and therefore the anode chamber 11 and cathode chamber 12 communicate with each other without being separated by the partition wall 6.

[0019] The melting point of $KF \cdot 2HF$ is $71.7^\circ C$, and therefore the temperature of the molten salt is regulated to 90 to $100^\circ C$. An amount of hydrogen fluoride corresponding to a vapor pressure vaporizes from the molten salt and intermixes with the fluorine gas and the hydrogen gas generated respectively from the anode 7 and the cathode 8 of the electrolytic cell 1. Accordingly, the fluorine gas generated in the anode 7 and led to the first gas chamber 11a and the hydrogen gas generated in the cathode 8 and led to the second gas chamber 12a respectively contain hydrogen fluoride gas.

[0020] A first pressure gauge 13 that detects a pressure in the first gas chamber 11a and a second pressure gauge 14 that detects a pressure in the second gas chamber 12a are provided in the electrolytic cell 1. Detection results from the first pressure gauge 13 and the second pressure gauge 14 are output to controllers 10a, 10b.

[0021] Next, the fluorine gas supply system 2 will be described.

[0022] A first main passage 15 for supplying the fluorine gas to the external device 4 is connected to the first gas chamber 11a.

[0023] A first pump 17 that suctions and conveys the fluorine gas from the first gas chamber 11a is provided in the first main passage 15. A positive displacement pump such as a bellows pump or a diaphragm pump is used as the first pump 17. A first recirculation passage 18 that connects a discharge side and a suction side of the first pump 17 is connected to the first main passage 15. A first pressure regulating valve 19 for returning fluorine gas discharged from the first pump 17 to the suction side of the first pump 17 is provided in the first recircula-

tion passage 18.

[0024] An opening of the first pressure regulating valve 19 is controlled by a signal output from the controller 10a. More specifically, the controller 10a controls the opening of the first pressure regulating valve 19 on the basis of the detection result from the first pressure gauge 13 such that the pressure in the first gas chamber 11a reaches a predetermined set value.

[0025] It should be noted that in FIG. 1, a downstream end of the first recirculation passage 18 is connected to a location of the first main passage 15 in the vicinity of the first pump 17, but the downstream end of the first recirculation passage 18 may be connected to the first gas chamber 11a. In other words, the fluorine gas discharged from the first pump 17 may be returned into the first gas chamber 11a.

[0026] A refining device 16 that refines the fluorine gas by scavenging the hydrogen fluoride gas intermixed into the main product gas is provided in the first main passage 15 upstream of the first pump 17. The refining device 16 includes a cartridge 16a through which the fluorine gas passes, and an adsorbent for adsorbing the hydrogen fluoride is accommodated in the cartridge 16a. The adsorbent is formed from a large number of sodium fluoride (NaF) porous beads. An adsorption capacity of sodium fluoride varies according to temperature, and therefore a heater 16b for regulating an internal temperature of the cartridge 16a is provided on the periphery of the cartridge 16a. By providing the refining device 16 upstream of the first pump 17 in this manner, the fluorine gas from which the hydrogen fluoride has been removed is led to the first pump 17. It should be noted that a low temperature refining device that separates and removes the hydrogen fluoride gas from the fluorine gas using a difference in the boiling points of fluorine and hydrogen fluoride may be used as the refining device 16.

[0027] A first buffer tank 21 for storing the fluorine gas conveyed by the first pump 17 is provided in the first main passage 15 downstream of the first pump 17. The fluorine gas stored in the buffer tank 21 is supplied to the external device 4. A flow meter 26 that detects a flow rate of the fluorine gas supplied to the external device 4 is provided downstream of the first buffer tank 21. A detection result from the flow meter 26 is output to a controller 10c. The controller 10c controls a current value supplied between the anode 7 and the cathode 8 from the power supply 9 on the basis of the detection result from the flow meter 26. More specifically, a fluorine gas amount generated in the anode 7 is controlled such that the first buffer tank 21 is replenished with an amount of fluorine gas corresponding to the amount of fluorine gas supplied to the external device 4 from the first buffer tank 21.

[0028] By controlling the fluorine gas amount generated in the anode 7 so that the fluorine gas supplied to the external device 4 is replaced by an equal amount of fluorine gas in this manner, an internal pressure of the first buffer tank 21 is maintained at a higher pressure than atmospheric pressure. The external device 4 that uses

the fluorine gas, on the other hand, is at atmospheric pressure, and therefore, by opening a valve provided in the external device 4, fluorine gas is supplied to the external device 4 from the first buffer tank 21 in accordance with a differential pressure between the first buffer tank 21 and the external device 4.

[0029] A branch passage 22 is connected to the first buffer tank 21, and a pressure regulating valve 23 that controls the internal pressure of the first buffer tank 21 is provided in the branch passage 22. Further, a pressure gauge 24 that detects the internal pressure of the first buffer tank 21 is provided therein. A detection result from the pressure gauge 24 is output to a controller 10d. When the internal pressure of the first buffer tank 21 exceeds a predetermined set value, specifically 0.9MPa, the controller 10d opens the pressure regulating valve 23 to discharge the fluorine gas in the first buffer tank 21. Thus, the pressure regulating valve 23 controls the internal pressure of the first buffer tank 21 so as not to exceed the predetermined pressure.

[0030] A second buffer tank 50 for storing the fluorine gas discharged from the first buffer tank 21 is provided in the branch passage 22 downstream of the pressure regulating valve 23. Hence, when the internal pressure of the first buffer tank 21 exceeds the predetermined pressure, the fluorine gas in the first buffer tank 21 is discharged through the pressure regulating valve 23, and the discharged fluorine gas is led into the second buffer tank 50. The second buffer tank 50 has a smaller capacity than the first buffer tank 21. A pressure regulating valve 51 that controls an internal pressure of the second buffer tank 50 is provided in the branch passage 22 downstream of the second buffer tank 50. Further, a pressure gauge 52 that detects the internal pressure of the second buffer tank 50 is provided therein. A detection result from the pressure gauge 52 is output to a controller 10f. The controller 10f controls an opening of the pressure regulating valve 51 so that the internal pressure of the second buffer tank 50 reaches a predetermined set value. Fluorine gas discharged from the second buffer tank 50 through the pressure regulating valve 51 is discharged after being rendered harmless. Thus, the pressure regulating valve 51 controls the internal pressure of the second buffer tank 50 to the set value. A carrier gas supply passage 46, to be described below, is connected to the second buffer tank 50.

[0031] Next, the byproduct gas processing system 3 will be described.

[0032] A second main passage 30 for discharging hydrogen gas to the outside is connected to the second gas chamber 12a.

[0033] A second pump 31 that conveys the hydrogen gas from the second gas chamber 12a is provided in the second main passage 30. A second recirculation passage 32 that connects a discharge side and a suction side of the second pump 31 is also connected to the second main passage 30. A second pressure regulating valve 33 for returning hydrogen gas discharged from the

second pump 31 to the suction side of the second pump 31 is provided in the second recirculation passage 32.

[0034] An opening of the second pressure regulating valve 33 is controlled by a signal output from the controller 10b. More specifically, the controller 10b controls the opening of the second pressure regulating valve 33 on the basis of the detection result from the second pressure gauge 14 such that the pressure in the second gas chamber 12a reaches a predetermined set value.

[0035] Hence, the pressure in the first gas chamber 11a and the pressure in the second gas chamber 12a are controlled to the predetermined set values by the first pressure regulating valve 19 and the second pressure regulating valve 33, respectively. The set pressures of the first gas chamber 11a and second gas chamber 12a are preferably controlled to equal pressures so that a liquid level difference does not occur between the liquid level of the molten salt in the first gas chamber 11a and the liquid level of the molten salt in the second gas chamber 12a.

[0036] A harm removing portion 34 is provided in the second main passage 30 downstream of the second pump 31, and the hydrogen gas conveyed by the second pump 31 is rendered harmless by the harm removing portion 34 and then discharged.

[0037] The fluorine gas generation device 100 includes a raw material supply system 5 that supplies the hydrogen fluoride serving as the raw material of the fluorine gas into the molten salt in the electrolytic cell 1. The raw material supply system 5 will now be described.

[0038] A raw material supply passage 41 that leads hydrogen fluoride supplied from a hydrogen fluoride supply source 40 into the molten salt in the electrolytic cell 1 is connected to the electrolytic cell 1. A flow control valve 42 for controlling a supply flow rate of the hydrogen fluoride is provided in the raw material supply passage 41.

[0039] A current integrator 43 that integrates the current supplied between the anode 7 and the cathode 8 is attached to the power supply 9. The current integrated by the current integrator 43 is output to a controller 10e. The controller 10e controls the supply flow rate of the hydrogen fluoride led into the molten salt by opening and closing the flow control valve 42 on the basis of a signal input from the current integrator 43. More specifically, the supply flow rate of the hydrogen fluoride is controlled such that the hydrogen fluoride electrolyzed in the molten salt is replaced. Even more specifically, the supply flow rate of the hydrogen fluoride is controlled such that a hydrogen fluoride concentration of the molten salt remains within a predetermined range.

[0040] The carrier gas supply passage 46 connected to the second buffer tank 50 is connected to the raw material supply passage 41. The carrier gas supply passage 46 is a passage for leading a carrier gas stored in the second buffer tank 50 into the raw material supply passage 41. The carrier gas is a gas for leading the hydrogen fluoride into the molten salt, and here, the fluorine gas

generated in the anode 7 of the electrolytic cell 1 and stored in the second buffer tank 50 is used. A shutoff valve 47 that switches between supplying the carrier gas and shutting off the supply is provided in the carrier gas supply passage 46.

[0041] As a general rule, the shutoff valve 47 is open while the fluorine gas generation device 100 is operative so that the carrier gas is supplied to the raw material supply passage 41 through the carrier gas supply passage 46. When the carrier gas is supplied into the molten salt in the cathode chamber 12 of the electrolytic cell 1, the fluorine gas serving as the carrier gas reacts with the hydrogen gas generated by the cathode 8. Therefore, the raw material supply passage 41 is connected to the electrolytic cell 1 so that hydrogen fluoride is led into the molten salt in the anode chamber 11, thereby ensuring that the fluorine gas serving as the carrier gas does not intermix with the hydrogen gas generated in the electrolytic cell 1. The fluorine gas serving as the carrier gas led into the molten salt in the anode chamber 11 is led back into the first main passage 15 from the first gas chamber 11a substantially without melting into the molten salt.

[0042] When fluorine gas is supplied into the molten salt in the electrolytic cell 1 in this manner, the molten salt liquid level in the electrolytic cell 1 may be pushed up by the fluorine gas. To prevent this, a liquid level meter that detects the liquid level may be provided in the electrolytic cell 1, an allowable variation width may be set with respect to the molten salt liquid level of the electrolytic cell 1, and the shutoff valve 47 may be open-close controlled so that the molten salt liquid level remains within the allowable variation width. More specifically, the shutoff valve 47 may be closed when the molten salt liquid level in the electrolytic cell 1 reaches an upper limit of the allowable variation width. A flow control valve capable of controlling a flow rate of the carrier gas may be provided instead of the shutoff valve 47, and an opening of the flow control valve may be controlled in accordance with the liquid level of the electrolytic cell 1.

[0043] Next, an operation of the fluorine gas generation device 100 having the above constitution will be described.

[0044] The flow rate of the fluorine gas used by the external device 4 is detected by the flow meter 26 provided between the first buffer tank 21 and the external device 4. The amount of fluorine gas generated in the anode 7 is controlled by controlling a voltage applied between the anode 7 and the cathode 8 on the basis of the detection result from the flow meter 26. The hydrogen fluoride in the molten salt consumed during the electrolysis is replaced with hydrogen fluoride from the hydrogen fluoride supply source 40.

[0045] By performing control such that the hydrogen fluoride in the molten salt is replenished in accordance with the amount of fluorine gas used by the external device 4 in this manner, the liquid level of the molten salt does not normally vary greatly. However, when the amount of fluorine gas used by the external device 4 varies

rapidly or a pressure of the hydrogen gas in the by-product gas processing system 3 varies rapidly, the pressure in the first gas chamber 11a and the second gas chamber 12a varies greatly, and as a result, the liquid level in the anode chamber 11 and the cathode chamber 12 varies greatly. When the liquid level in the anode chamber 11 and the cathode chamber 12 varies greatly such that the liquid level falls below the partition wall 6, the first gas chamber 11a and the second gas chamber 12a communicate with each other. In this case, the fluorine gas and the hydrogen gas intermix and react.

[0046] To suppress variation in the liquid level in the anode chamber 11 and the cathode chamber 12, the pressure in the first gas chamber 11a and the pressure in the second gas chamber 12a are controlled to the predetermined set value on the basis of the detection results from the first pressure gauge 13 and the second pressure gauge 14, respectively. Hence, the liquid level in the anode chamber 11 and the cathode chamber 12 is controlled by keeping the pressure in the first gas chamber 11a and the second gas chamber 12a constant.

[0047] The hydrogen fluoride supplied from the hydrogen fluoride supply source 40 is led into the molten salt in the anode chamber 11 of the electrolytic cell 1 by the fluorine gas supplied into the raw material supply passage 41 from the second buffer tank 50 via the carrier gas supply passage 46. As a result, supplementary hydrogen fluoride is supplied to the electrolytic cell 1 by the fluorine gas stored in the second buffer tank 50.

[0048] When nitrogen gas is used as the carrier gas, as in the prior art, and the nitrogen gas contains moisture, the moisture is carried into the electrolytic cell 1. When the fluorine gas in the second buffer tank 50 is used as the carrier gas, on the other hand, the fluorine gas is dewatered and electrolyzed by the electrolytic cell 1, and therefore moisture is not carried into the electrolytic cell 1.

[0049] Further, even when the hydrogen fluoride supplied from the hydrogen fluoride supply source 40 is anhydrous hydrogen fluoride, approximately 3000 to 400ppm of moisture is contained therein. When the fluorine gas in the second buffer tank 50 is used as the carrier gas, the fluorine gas reacts with the moisture in the hydrogen fluoride, whereby hydrogen fluoride, oxygen, and oxygen difluoride (OF_2) are generated. Hence, when fluorine gas is used as the carrier gas, a dewatering effect is obtained with respect to the moisture in the hydrogen fluoride.

[0050] The fluorine gas serving as the carrier gas that is led into the molten salt in the anode chamber 11 is led back into the first main passage 15 from the first gas chamber 11a together with the fluorine gas generated by the anode 7, and then led into the first buffer tank 21 by the first pump 17. The internal pressure of the first buffer tank 21 is controlled by the pressure regulating valve 23 so as not to exceed the predetermined pressure, but when the internal pressure of the first buffer tank 21 does exceed the predetermined pressure, the fluorine gas in the first buffer tank 21 is discharged into the second buffer

tank 50 via the pressure regulating valve 23. The fluorine gas led into the second buffer tank 50 in this manner is used as the carrier gas. The internal pressure of the second buffer tank 50 is controlled to the set value by the pressure regulating valve 51 such that the fluorine gas is supplied with stability from the second buffer tank 50 into the raw material supply passage 41 via the carrier gas supply passage 46. The set value is determined taking into consideration the pressure of the hydrogen fluoride in the raw material supply passage 41, a pipe resistance of the carrier gas supply passage 46, and so on.

[0051] In the fluorine gas generation device 100 described above, fluorine gas that is conventionally discharged to the outside from the first buffer tank 21, of the fluorine gas generated by the anode 7 of the electrolytic cell 1, is used as the carrier gas. In other words, the fluorine gas generation device 100 stores the fluorine gas that is conventionally discharged to the outside from the first buffer tank 21 in the second buffer tank 50, and uses the stored fluorine gas as the carrier gas. The fluorine gas used as the carrier gas is led back into the first main passage 15 from the first gas chamber 11a of the electrolytic cell 1 and recirculated through the fluorine gas generation device 100.

[0052] According to the first embodiment described above, the following actions and effects are obtained.

[0053] In the fluorine gas generation device 100, the fluorine gas generated by the anode 7 of the electrolytic cell 1 is used as the carrier gas, and therefore the facility can be constructed simply without the need to provide a dedicated carrier gas supply source, as in the prior art. Further, the fluorine gas that is conventionally discharged to the outside from the first buffer tank 21 is used as the carrier gas, and therefore running costs can be reduced.

[0054] Another aspect of the first embodiment will now be described.

[0055] In the first embodiment, the fluorine gas stored in the second buffer tank 50 is used as the carrier gas. However, the fluorine gas stored in the first buffer tank 21 may be used as the carrier gas. In this case, the carrier gas supply passage 46 is formed to connect the first buffer tank 21 to the raw material supply passage 41. It should be noted, however, that in this case, the pressure in the first buffer tank 21 varies easily, and therefore the pressure of the fluorine gas supplied to the external device 4 may vary. Therefore, as described in the first embodiment, the fluorine gas stored in the second buffer tank 50 is preferably used as the carrier gas.

(Second Embodiment)

[0056] Referring to FIG. 2, a fluorine gas generation device 200 according to a second embodiment of this invention will be described. The following description focuses on differences with the first embodiment. Accordingly, identical reference symbols have been allocated to similar constitutions to those of the first embodiment and description thereof has been omitted.

[0057] The fluorine gas generation device 200 differs from the fluorine gas generation device 100 according to the first embodiment in that the hydrogen gas generated in the cathode 8 of the electrolytic cell 1 is used as the carrier gas.

[0058] The byproduct gas processing system 3 will now be described.

[0059] A buffer tank 60 for storing the hydrogen gas that is generated by the cathode 8 of the electrolytic cell 1 and conveyed by the second pump 31 is provided in the second main passage 30 downstream of the second pump 31. A pressure regulating valve 61 that controls an internal pressure of the buffer tank 60 is provided in the second main passage 30 downstream of the buffer tank 60. Further, a pressure gauge 62 that detects the internal pressure of the buffer tank 60 is provided therein. A detection result from the pressure gauge 62 is output to a controller 10g. The controller 10g controls an opening of the pressure regulating valve 61 so that the internal pressure of the buffer tank 60 reaches a predetermined set value. Thus, the pressure regulating valve 61 controls the internal pressure of the buffer tank 60 to the set value.

[0060] The harm removing portion 34 is provided in the second main passage 30 downstream of the pressure regulating valve 61. The hydrogen gas discharged from the buffer tank 60 via the pressure regulating valve 61 is rendered harmless by the harm removing portion 34 and then discharged.

[0061] The carrier gas supply passage 46, a downstream end of which is connected to the raw material supply passage 41, is connected to the buffer tank 60. The hydrogen gas stored in the buffer tank 60 is led into the raw material supply passage 41 through the carrier gas supply passage 46. The shutoff valve 47 that switches between supplying the carrier gas and shutting off the supply is provided in the carrier gas supply passage 46.

[0062] As a general rule, the shutoff valve 47 is open while the fluorine gas generation device 200 is operative so that the carrier gas is supplied to the raw material supply passage 41 through the carrier gas supply passage 46. When the carrier gas is supplied into the molten salt in the anode chamber 11 of the electrolytic cell 1, the hydrogen gas serving as the carrier gas reacts with the fluorine gas generated by the anode 7. Therefore, the raw material supply passage 41 is connected to the electrolytic cell 1 so that hydrogen fluoride is led into the molten salt in the cathode chamber 12, thereby ensuring that the hydrogen gas serving as the carrier gas does not intermix with the fluorine gas generated in the electrolytic cell 1. The hydrogen gas serving as the carrier gas led into the molten salt in the cathode chamber 12 is led back into the second main passage 30 from the second gas chamber 12a substantially without melting into the molten salt.

[0063] When hydrogen gas is supplied into the molten salt in the electrolytic cell 1 in this manner, the molten salt liquid level in the electrolytic cell 1 may be pushed up by the hydrogen gas. To prevent this, a liquid level

meter that detects the liquid level may be provided in the electrolytic cell 1, an allowable variation width may be set with respect to the molten salt liquid level of the electrolytic cell 1, and the shutoff valve 47 may be open-close controlled so that the molten salt liquid level remains within the allowable variation width. More specifically, the shutoff valve 47 may be closed when the molten salt liquid level in the electrolytic cell 1 reaches the upper limit of the allowable variation width. A flow control valve capable of controlling the flow rate of the carrier gas may be provided instead of the shutoff valve 47, and the opening of the flow control valve may be controlled in accordance with the liquid level of the electrolytic cell 1.

[0064] As regards the fluorine gas supply system 2, the fluorine gas generation device 200 does not use fluorine gas as the carrier gas, and therefore the second buffer tank 50 and the pressure regulating valve 51 described above in the first embodiment are not required. The fluorine gas discharged from the first buffer tank 21 through the pressure regulating valve 23 is discharged after being rendered harmless.

[0065] Next, an operation of the fluorine gas generation device 200 will be described, focusing particularly on the carrier gas.

[0066] The hydrogen fluoride supplied from the hydrogen fluoride supply source 40 is led into the molten salt in the cathode chamber 12 of the electrolytic cell 1 by the hydrogen gas that is supplied to the raw material supply passage 41 from the buffer tank 60 via the carrier gas supply passage 46. As a result, supplementary hydrogen fluoride is supplied to the electrolytic cell 1 by the hydrogen gas stored in the buffer tank 60.

[0067] The nitrogen gas used as the carrier gas is de-watered and electrolyzed by the electrolytic cell 1, and therefore, similarly to the first embodiment, moisture is not carried into the electrolytic cell 1.

[0068] The hydrogen gas serving as the carrier gas that is led into the molten salt in the cathode chamber 12 is led back into the second main passage 30 from the second gas chamber 12a together with the hydrogen gas generated by the cathode 8, and then led into the buffer tank 60 by the second pump 31. The hydrogen gas led into the buffer tank 60 in this manner is used as the carrier gas. The internal pressure of the buffer tank 60 is controlled to the set value by the pressure regulating valve 61 such that the hydrogen gas is supplied with stability from the buffer tank 60 into the raw material supply passage 41 via the carrier gas supply passage 46. The set value is determined taking into consideration the pressure of the hydrogen fluoride in the raw material supply passage 41, the pipe resistance of the carrier gas supply passage 46, and so on.

[0069] Hence, in the fluorine gas generation device 200, the hydrogen gas that is generated by the cathode 8 of the electrolytic cell 1 and conventionally discharged to the outside is used as the carrier gas. In other words, the fluorine gas generation device 200 uses the byproduct gas generated by electrolyzing the hydrogen fluoride

as the carrier gas. The hydrogen gas used as the carrier gas is led back into the second main passage 30 from the second gas chamber 12a of the electrolyte cell 1, and recirculated through the fluorine gas generation device 200.

[0070] According to the second embodiment, the following actions and effects are obtained.

[0071] In the fluorine gas generation device 200, the hydrogen gas generated by the cathode 8 of the electrolytic cell 1 is used as the carrier gas, and therefore the facility can be constructed simply without the need to provide a dedicated carrier gas supply source, as in the prior art. Further, the byproduct gas that is conventionally discharged to the outside is used as the carrier gas, and therefore running costs can be reduced.

[0072] Another aspect of the second embodiment will now be described.

[0073] In the second embodiment, the hydrogen gas stored in the buffer tank 60 is used as the carrier gas. However, the carrier gas may be extracted directly from the second main passage 30. In this case, the carrier gas supply passage 46 may be formed to connect the raw material supply passage 41 to the second main passage 30 downstream of the second pump, and a pressure regulating valve may be provided in the carrier gas supply passage 46 to control a supply pressure of the carrier gas.

[0074] This invention is not limited to the embodiments described above and may of course be subjected to various modifications within the scope of the technical idea thereof.

[0075] For example, in the above embodiments, the controllers 10a to 10g are provided separately, but overall control may be performed by a single controller.

[0076] With respect to the above description, the contents of Japanese patent application No. 2009-89438, with a filing date of April 1, 2009, are incorporated herein by reference.

INDUSTRIAL APPLICABILITY

[0077] This invention may be applied to a device that generates fluorine gas.

Claims

1. A fluorine gas generation device that generates fluorine gas by electrolyzing hydrogen fluoride in molten salt, comprising:

an electrolytic cell storing the molten salt, in which a first gas chamber to which a main product gas having fluorine gas generated by an anode submerged in the molten salt as a main component is led and a second gas chamber to which a byproduct gas having hydrogen gas generated by a cathode submerged in the molten salt as a main component is led are sepa-

rated and defined above a liquid level of the molten salt;

a raw material supply passage that is connected to the electrolytic cell to lead the hydrogen fluoride into the molten salt; and

a carrier gas supply passage that is connected to the raw material supply passage to lead a carrier gas for leading the hydrogen fluoride into the molten salt to the raw material supply passage,

wherein the fluorine gas generated by the anode in the electrolytic cell or the hydrogen gas generated by the cathode in the electrolytic cell is used as the carrier gas.

2. The fluorine gas generation device as defined in Claim 1, comprising:

a first main passage connected to the first gas chamber in order to supply the fluorine gas generated by the anode in the electrolytic cell to an external device;

a first buffer tank provided in the first main passage in order to store the fluorine gas;

a branch passage connected to the first buffer tank;

a pressure regulating valve provided in the branch passage in order to control an internal pressure of the first buffer tank; and

a second buffer tank for storing fluorine gas discharged from the first buffer tank through the pressure regulating valve,

wherein, when fluorine gas is used as the carrier gas, the fluorine gas stored in the first buffer tank or the second buffer tank is used.

3. The fluorine gas generation device as defined in Claim 1, comprising:

a second main passage connected to the second gas chamber, to which the hydrogen gas generated by the cathode in the electrolytic cell is led; and

a buffer tank provided in the second main passage in order to store the hydrogen gas,

wherein, when hydrogen gas is used as the carrier gas, the hydrogen gas stored in the buffer tank is used.

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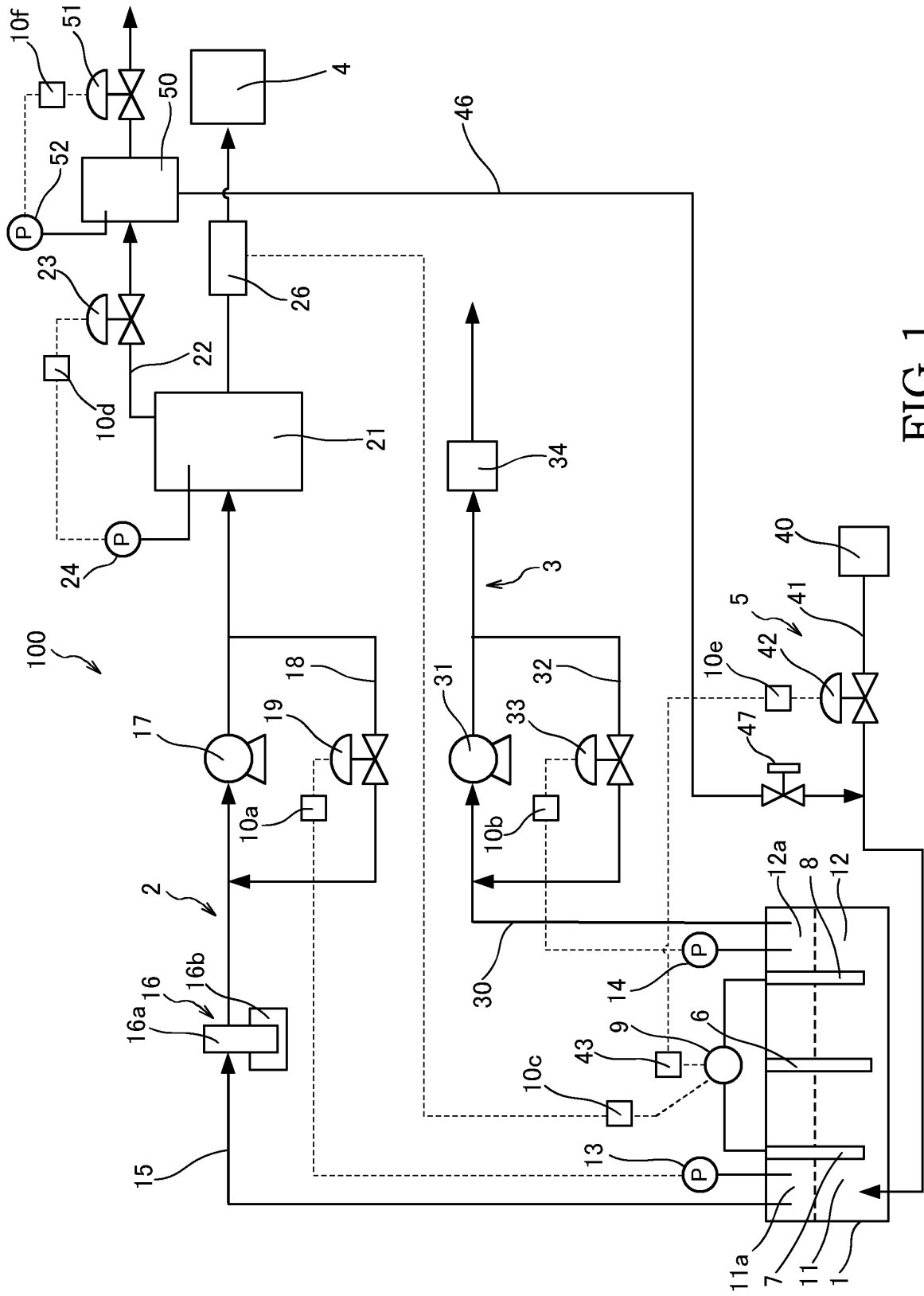


FIG. 1

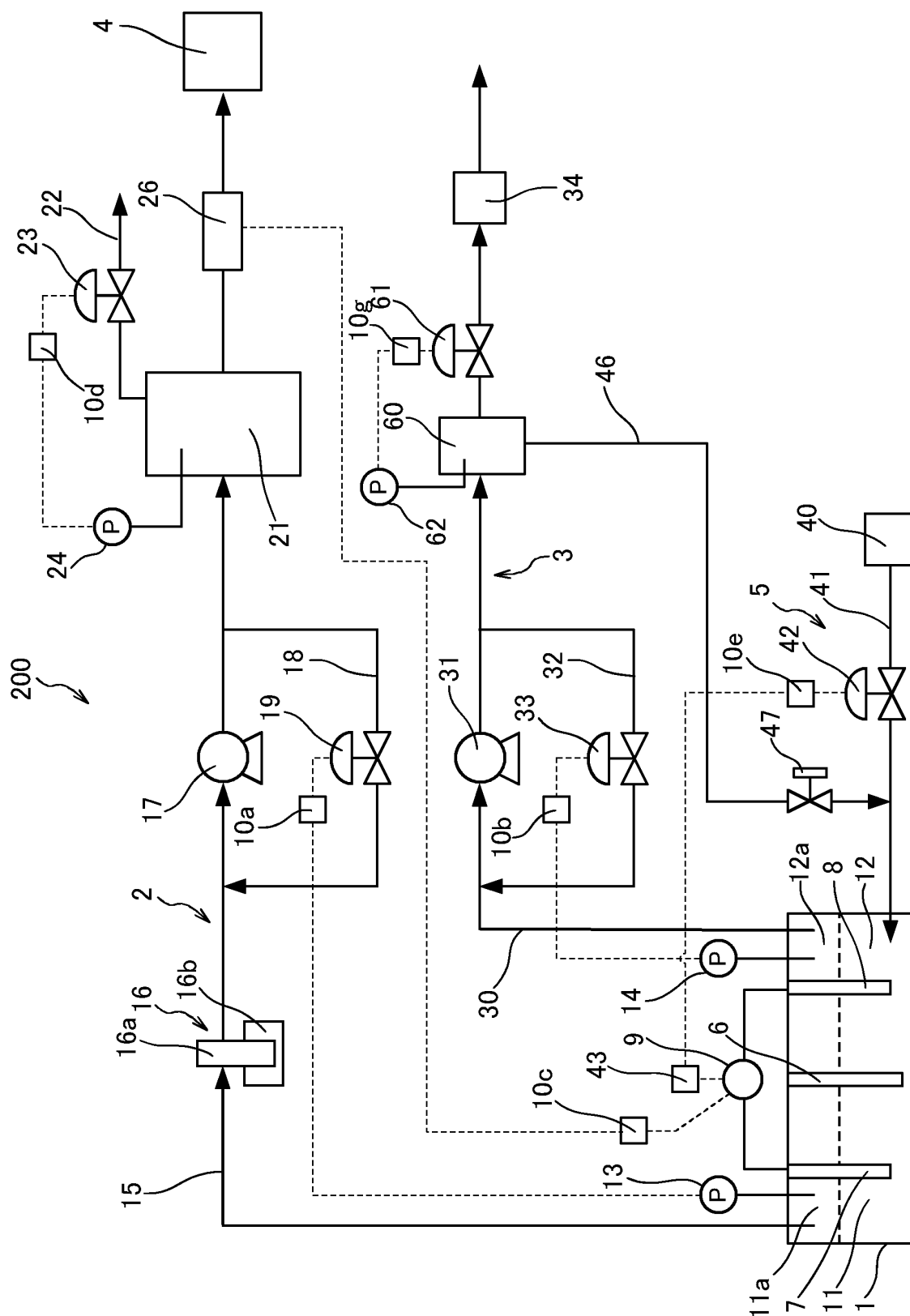


FIG.2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2010/054067

A. CLASSIFICATION OF SUBJECT MATTER

C25B15/08(2006.01) i, C25B1/24(2006.01) i, C25B9/00(2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C25B15/08, C25B1/24, C25B9/00, C01B7/20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2010

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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2009-24222 A (Toyo Tanso Co., Ltd.), 05 February 2009 (05.02.2009), entire text & WO 2009/014078 A1	1-3
A	JP 2004-43885 A (L'Air Liquide, Societe Anonyme a Directoire et Conseil de Surveillance pour l'Etude et l'Exploitation des Procedes Georges Claude), 12 February 2004 (12.02.2004), entire text & WO 2004/007802 A2 & CN 1668779 A	1-3

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search
06 April, 2010 (06.04.10)Date of mailing of the international search report
20 April, 2010 (20.04.10)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2004043885 A [0003] [0004] [0005]
- JP 2009089438 A [0076]