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(54) **METHODS AND APPARATUS FOR REDUCING THE CONSUMPTION OF REAGENTS IN ELECTRONIC DEVICE MANUFACTURING PROCESSES**

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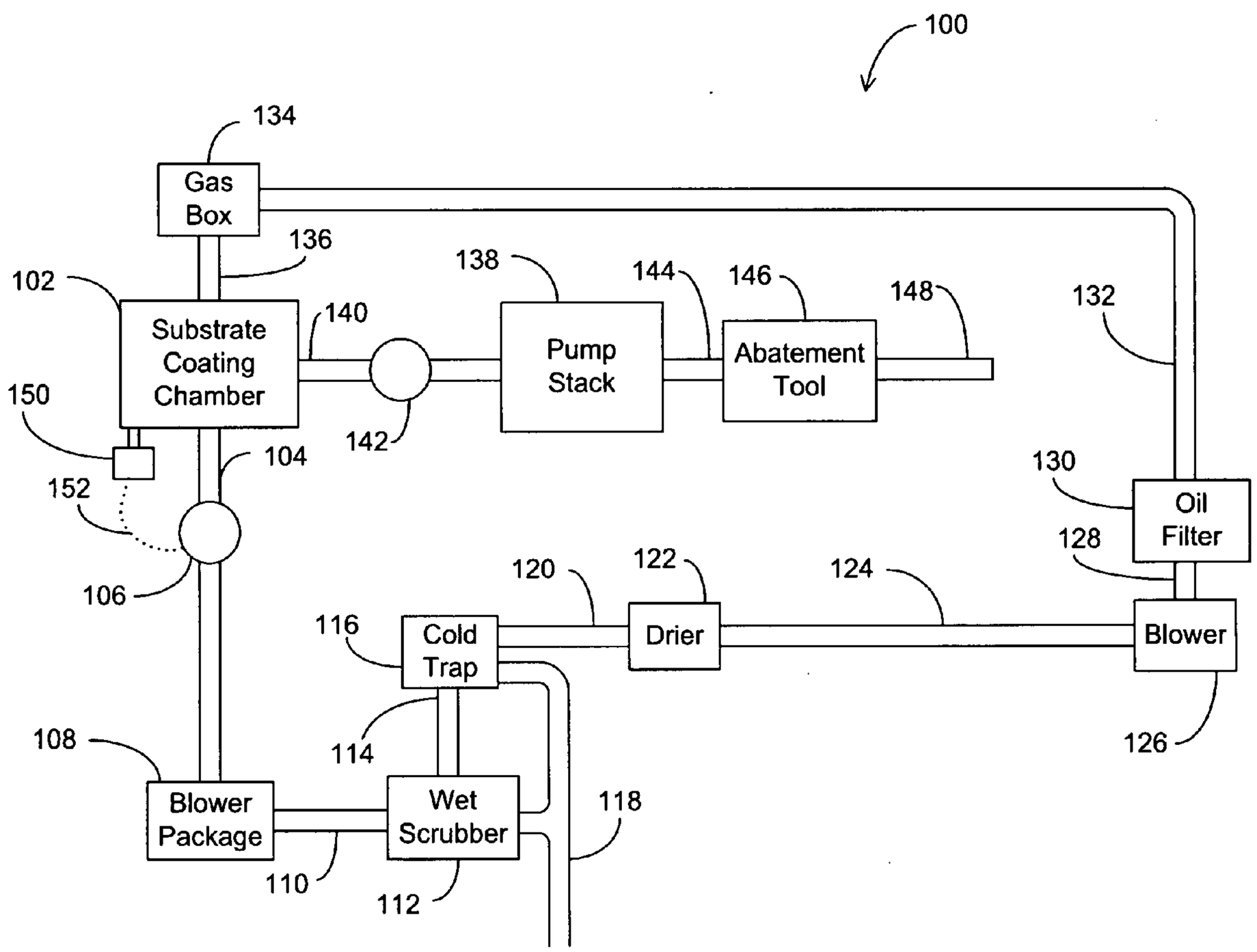
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(57) **ABSTRACT**

A substrate coating system is provided which includes a substrate coating chamber; a gas box connected to the coating chamber and adapted to provide reagent gases to the coating chamber; and a reagent reclaim system connected to the substrate coating chamber and the gas box, wherein the reagent reclaim system includes a wet scrubber connected to the coating chamber; a polisher connected to the wet scrubber; and a dryer connected to the polisher and the gas box.



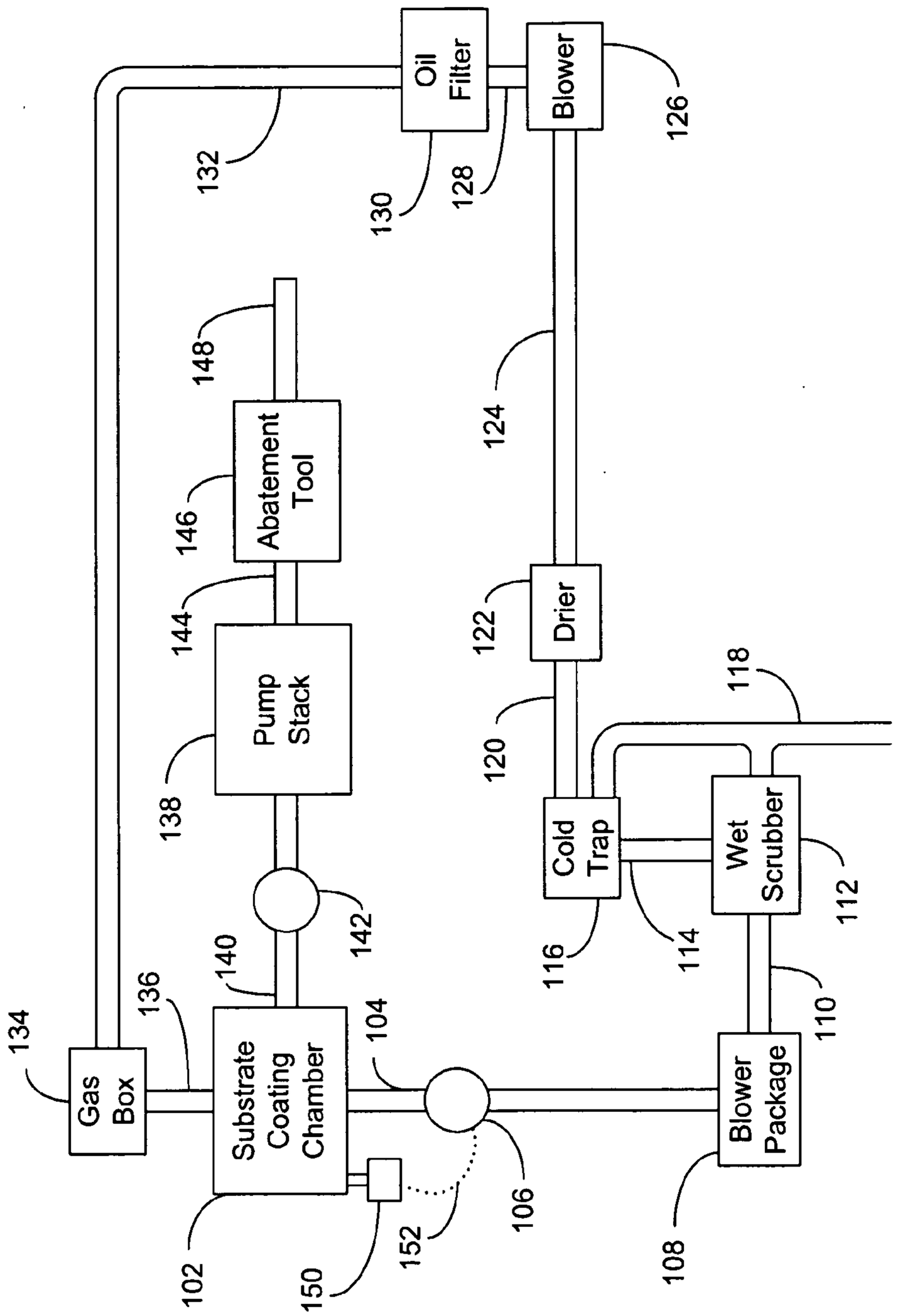

100
Oil Filter
Blower
126
132
130
128
148
Abatement Tool
146
144
Pump Stack
138
142
140
136
134
Gas Box
Substrate Coating Chamber
104
102
150
152
106
124
Drier
122
120
118
Cold Trap
Wet Scrubber
116
114
112
110
Blower Package
108

FIG. 1

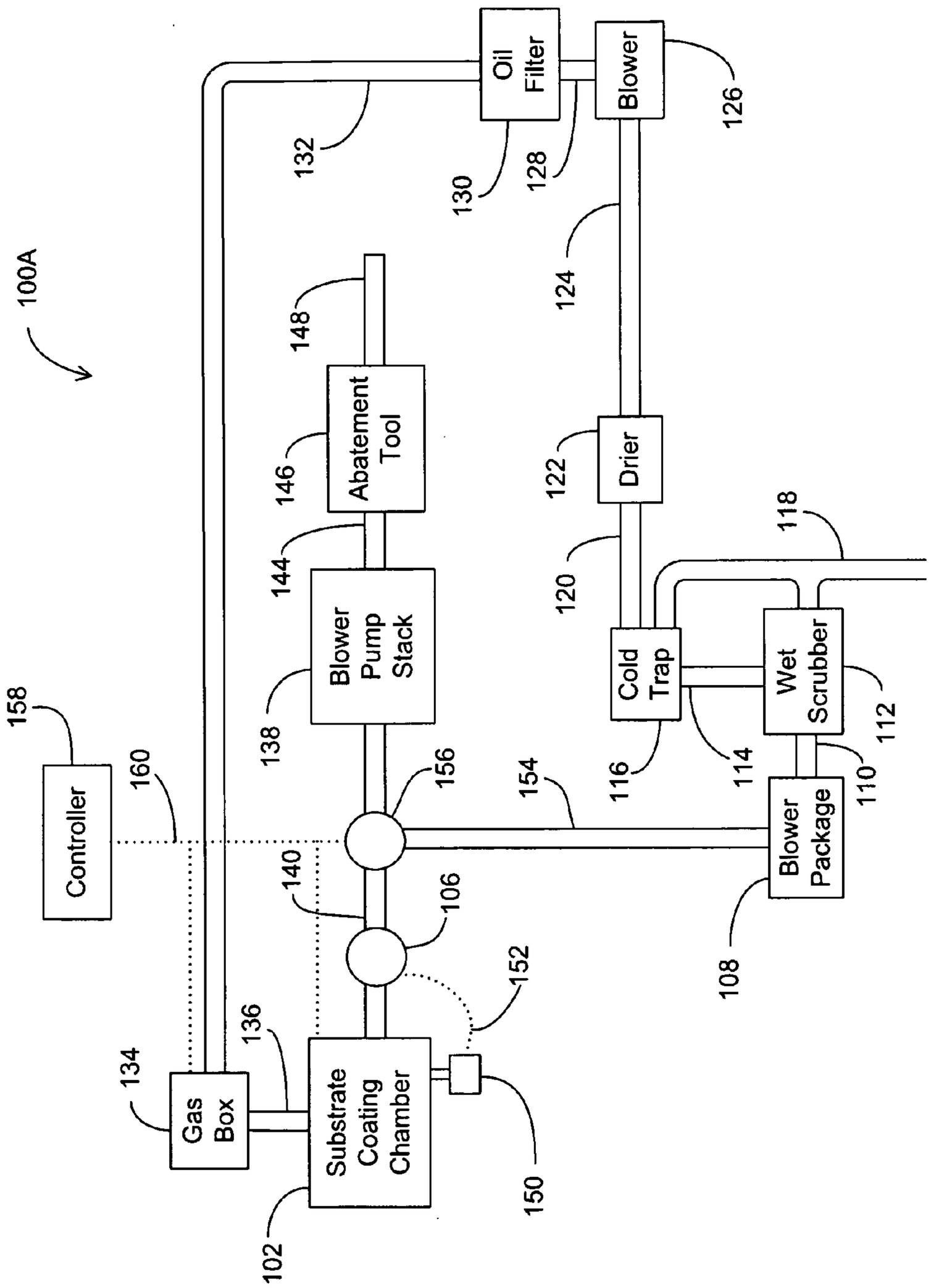

100A
Oil Filter
Blower
126
132
130
128
124
148
Abatement Tool
146
122
Drier
144
Blower Pump Stack
120
118
158
Cold Trap
Wet Scrubber
138
116
114
112
160
Controller
156
154
110
Blower Package
140
106
108
152
134
136
Gas Box
Substrate Coating Chamber
150
102

FIG. 1A

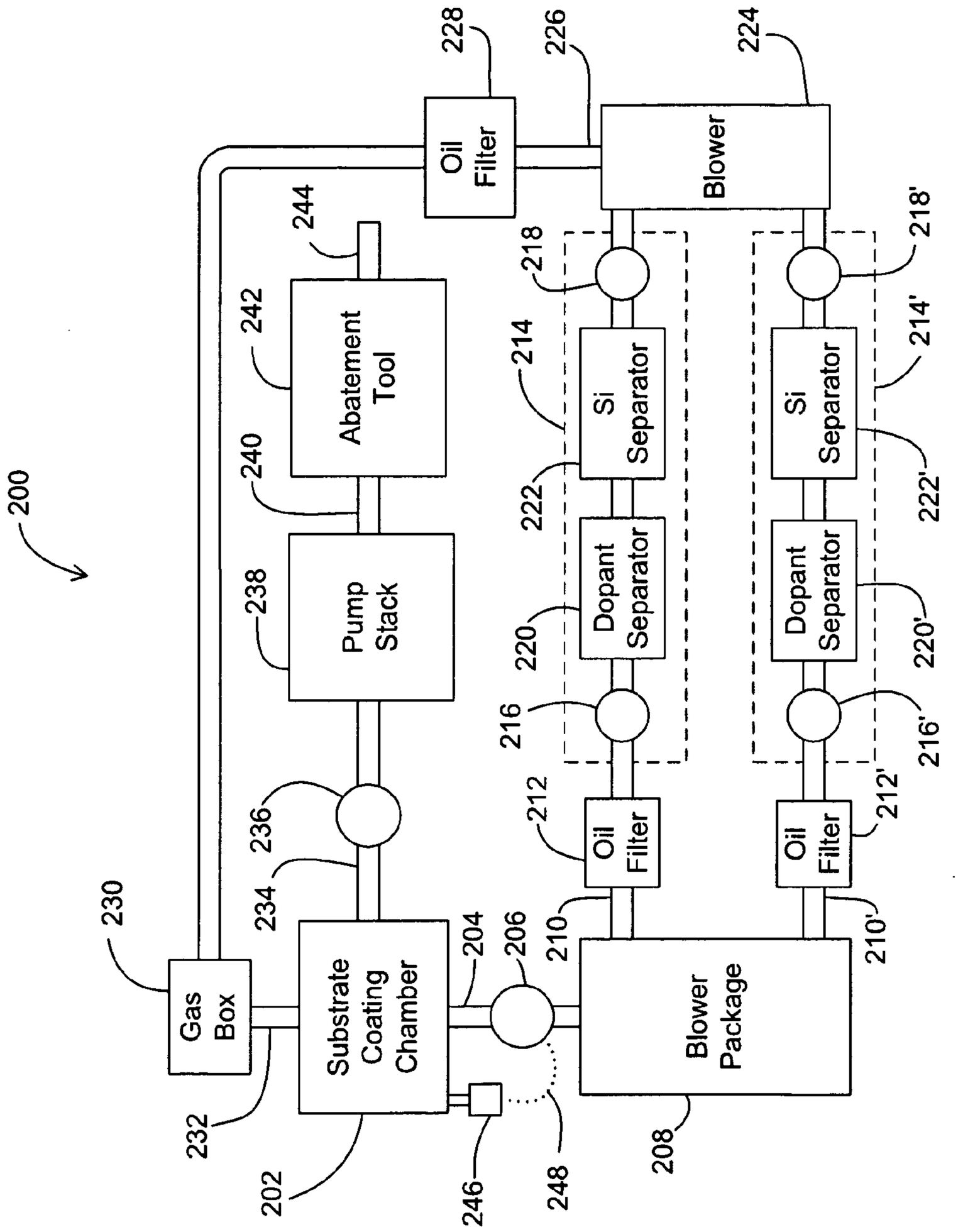

200
228
226
224
Oil Filter
Blower
244
242
Abatement Tool
240
238
Pump Stack
218
214
Si Separator
222
220
Dopant Separator
216
212
Oil Filter
218'
214'
Si Separator
222'
220'
Dopant Separator
216'
212'
Oil Filter
236
234
230
Gas Box
Substrate Coating Chamber
204
206
210
210'
Blower Package
232
202
246
248
208

FIG. 2

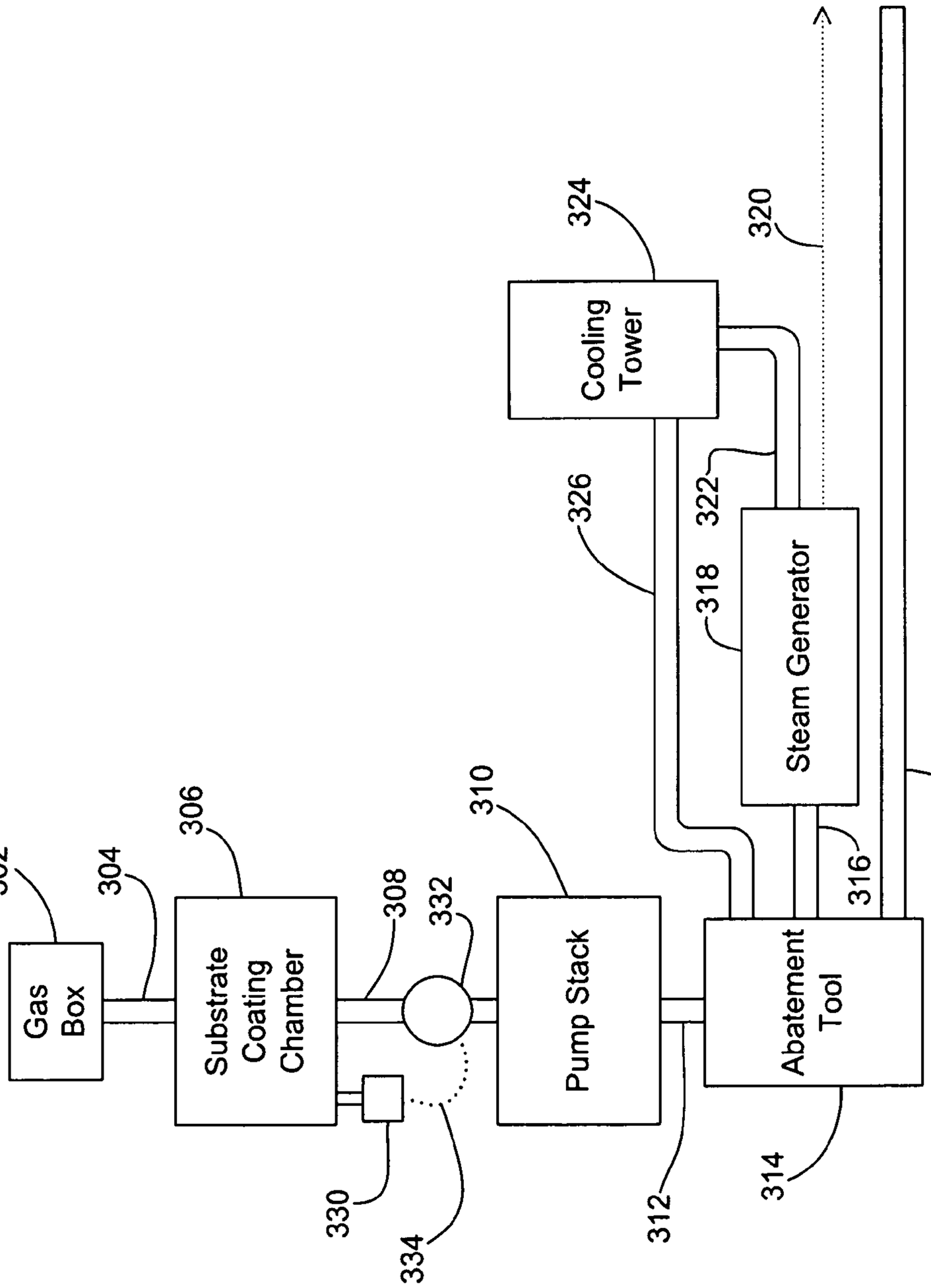

300
302
304
306
308
310
312
314
316
318
320
322
324
326
328
330
332
334
Gas Box
Substrate Coating Chamber
Pump Stack
Abatement Tool
Steam Generator
Cooling Tower

FIG. 3

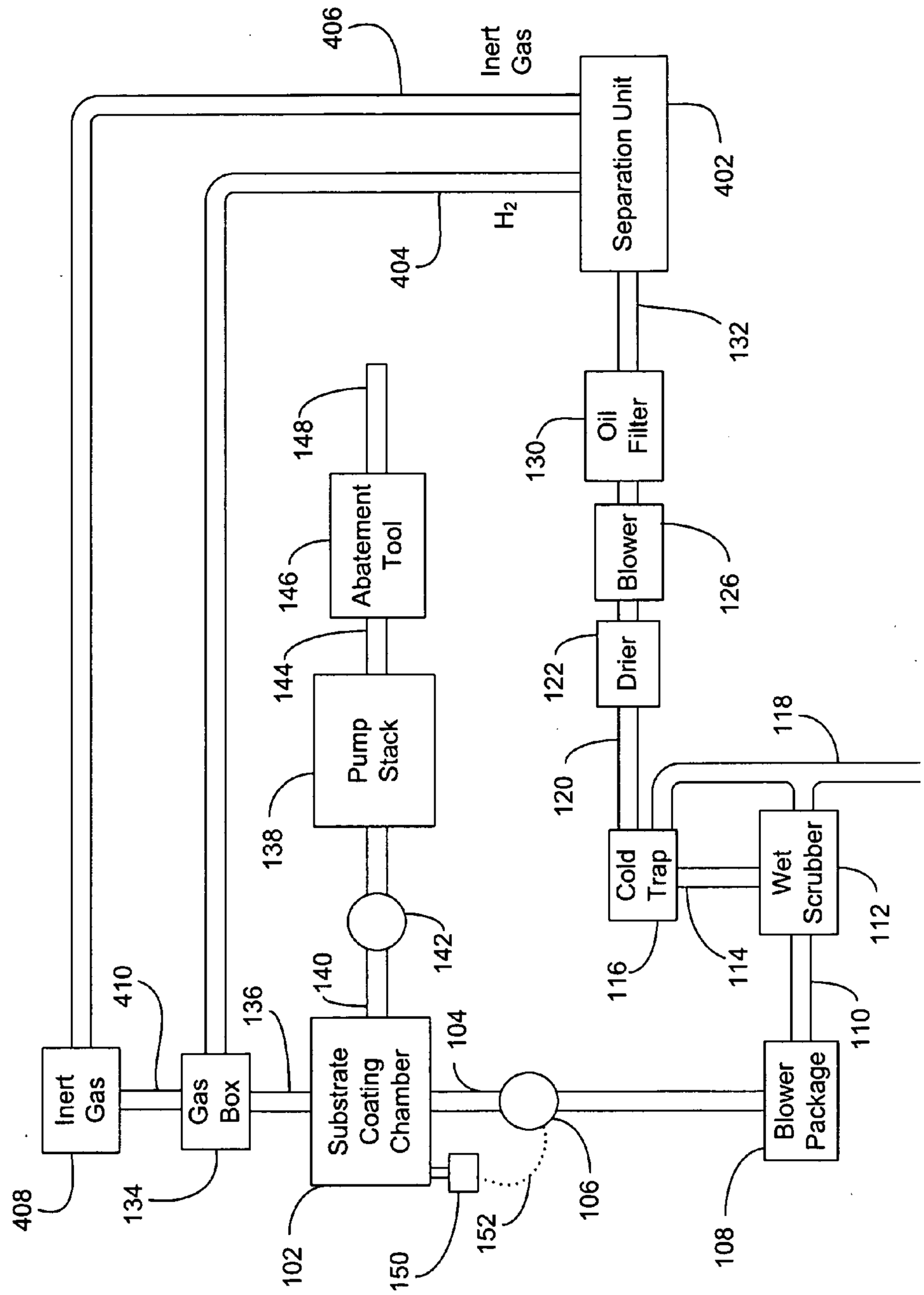

400
406
Inert Gas
Separation Unit
402
H_2
404
132
Oil Filter
130
Blower
126
Drier
122
120
118
Cold Trap
Wet Scrubber
112
116
114
110
Blower Package
108
148
Abatement Tool
146
144
Pump Stack
138
142
140
136
Substrate Coating Chamber
104
102
150
152
106
Inert Gas
408
410
Gas Box
134

FIG. 4

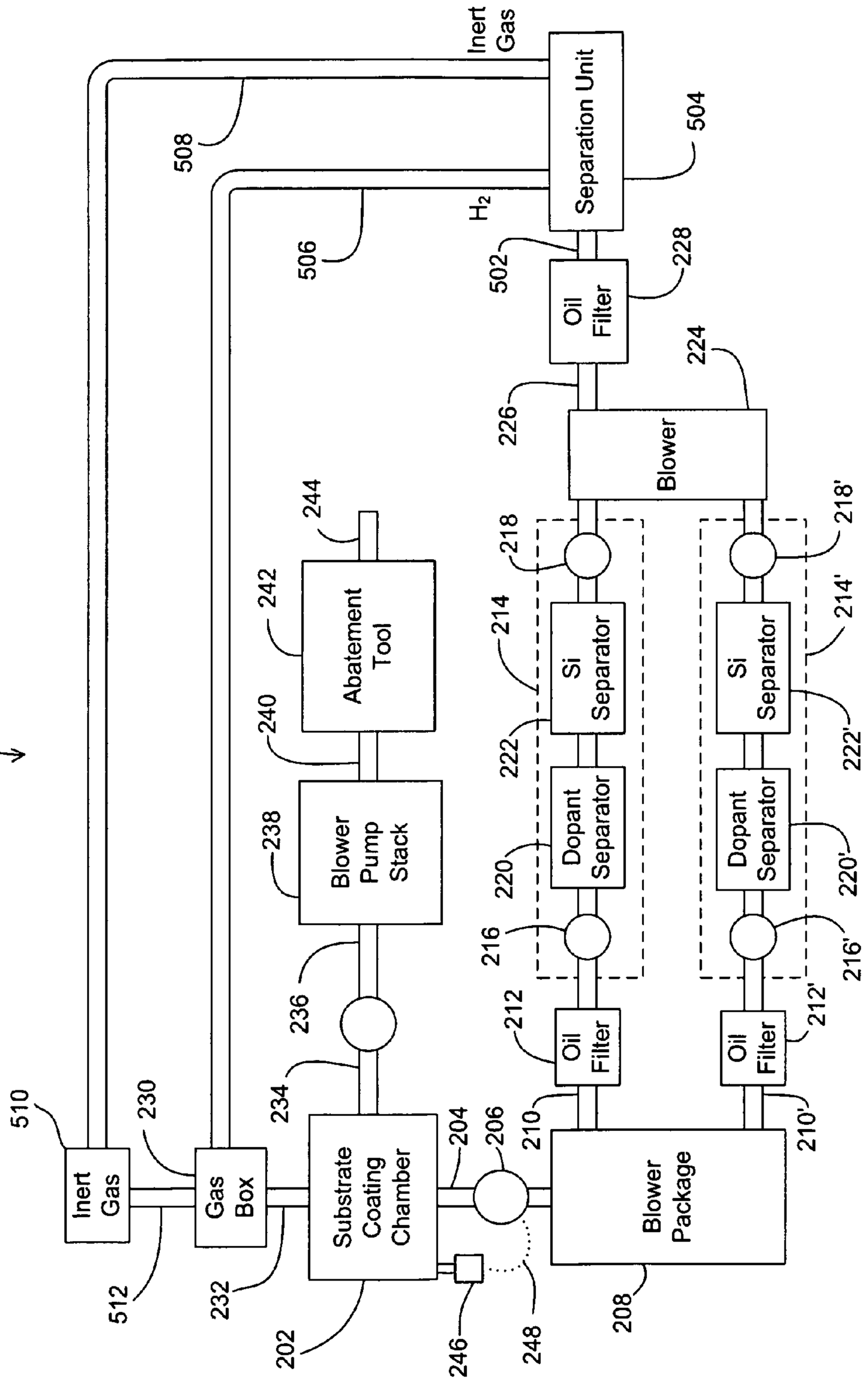

500
Inert Gas
508
Separation Unit
504
H_2
506
502
228
Oil Filter
224
226
Blower
218
218'
214
214'
Si Separator
222
222'
Dopant Separator
220
220'
216
216'
212
212'
Oil Filter
210
210'
Blower Package
208
204
206
Substrate Coating Chamber
234
236
202
246
248
240
242
244
Abatement Tool
238
Blower Pump Stack
230
232
Gas Box
510
512
Inert Gas

FIG. 5

METHODS AND APPARATUS FOR REDUCING THE CONSUMPTION OF REAGENTS IN ELECTRONIC DEVICE MANUFACTURING PROCESSES

[0001] The present application claims priority to U.S. Provisional Patent Application Ser. No. 60/944,487, filed Jun. 16, 2007 and entitled "SYSTEMS AND METHODS OF H_2 EFFLUENT RECYCLING FOR SOLAR ABATEMENT APPLICATIONS" (Attorney Docket No. 12189/L), which is hereby incorporated herein by reference in its entirety for all purposes.

[0002] The present application claims priority to U.S. Provisional Patent Application Ser. No. 60/988,771, filed Nov. 16, 2007 and entitled "SYSTEMS AND METHODS OF H_2 EFFLUENT RECYCLING FOR SOLAR ABATEMENT APPLICATIONS" (Attorney Docket No. 12189/L2), which is hereby incorporated herein by reference in its entirety for all purposes.

RELATED APPLICATIONS

[0003] Co-owned U.S. patent application No. 61/052,164, filed May 9, 2008 and entitled "METHODS AND APPARATUS FOR REDUCING THE CONSUMPTION OF REAGENTS IN ELECTRONIC DEVICE MANUFACTURING PROCESSES" (Attorney Docket No. 13543), is hereby incorporated by reference herein in its entirety and for all purposes.

[0004] Co-assigned U.S. patent application Ser. No. 11/565,400 filed Nov. 30, 2006, and entitled "Dilution Gas Recirculation", (Attorney Docket No. 11402), is hereby incorporated herein by reference in its entirety for all purposes.

[0005] Co-assigned U.S. Patent Application No. 61/039,101, filed Mar. 24, 2008, and entitled "METHODS FOR USING REDUCED PURITY SILANE TO DEPOSIT AMORPHOUS AND MICROCRYSTALLINE SILICON", (Attorney Docket No. 13226/L), is hereby incorporated herein by reference in its entirety for all purposes.

[0006] Co-assigned U.S. Patent Application No. 61/026,432, filed Feb. 5, 2008, and entitled "Abatement Systems", (Attorney Docket No. 13208/L2), is hereby incorporated herein by reference in its entirety for all purposes.

FIELD OF THE INVENTION

[0007] The present invention relates generally to electronic device manufacturing and is more particularly directed to the reclaim and recycle of reagent gases which are used in substrate coating processes.

BACKGROUND OF THE INVENTION

[0008] Some electronic device manufacturing processes may use large quantities of expensive reagents and some of these reagents may be harmful and/or hazardous if released to the atmosphere. It is known to abate these reagents and their byproducts through the use of abatement systems which convert the reagents or their byproducts into less harmful and/or hazardous compounds. The abatement of these reagents and their byproducts may address the issue of the harmful and/or hazardous nature of the reagents/byproducts.

[0009] Abatement may not, however, address the fact that a significant quantity of expensive reagents may be purchased and eventually abated when the reagents pass unused through a process chamber.

[0010] It is desirable to develop methods and apparatus which would reduce the amount of expensive reagents which are abated.

SUMMARY OF THE INVENTION

[0011] In one aspect the invention provides a substrate coating system which includes 1) a substrate coating chamber; 2) a gas box connected to the coating chamber and adapted to provide reagent gases to the coating chamber; and 3) a reagent reclaim system connected to the substrate coating chamber and the gas box, wherein the reagent reclaim system includes a) a scrubber connected to the coating chamber; a polisher connected to the scrubber; and a dryer connected to the polisher and the gas box.

[0012] In another aspect the invention provides a substrate coating system which includes 1) a substrate coating chamber; 2) a gas box connected to the coating chamber and adapted to provide reagent gases to the coating chamber; and 3) a reagent reclaim system connected to the substrate coating chamber and the gas box, wherein the reagent reclaim system includes a) a reagent filter connected to the coating chamber; and b) a dopant filter connected to the reagent filter.

[0013] In yet another aspect, the invention provides a method of operating a substrate coating system which includes a) supplying more than one reagent to a substrate coating chamber; b) coating a substrate in the substrate coating chamber; c) exhausting unused reagents from the substrate coating chamber; and d) reclaiming a reagent for reuse as a reagent in the substrate coating chamber.

[0014] Numerous other aspects are provided in accordance with these and other aspects of the invention. Other features and aspects of the present invention will become more fully apparent from the following detailed description, the appended claims and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. **1** is a schematic depiction of a substrate coating system of the invention which is adapted to recycle hydrogen gas.

[0016] FIG. **1**A is a schematic depiction of another embodiment of the system of FIG. **1**.

[0017] FIG. **2** is a schematic depiction of another apparatus of the invention for recycling hydrogen gas and reclaiming silicon.

[0018] FIG. **3** is a schematic depiction of a substrate coating system of the invention which includes a co-generation apparatus.

[0019] FIG. **4** is a schematic depiction of another embodiment of the system of FIG. **1**.

[0020] FIG. **5** is a schematic depiction of another embodiment of the system of FIG. **2**.

DETAILED DESCRIPTION

[0021] Electronic device manufacturing processes may use large amounts of reagents, such as silane and hydrogen. A substantial portion of these reagents which may be expensive and/or scarce may pass from a process chamber unused, to be treated as waste.

[0022] In a typical substrate coating process prior to the invention, silane and hydrogen gases may be introduced into a substrate coating chamber under substrate coating process conditions. A significant amount of the hydrogen and silane may pass through the substrate coating chamber unused. It is known to treat the unused hydrogen and silane as harmful and/or dangerous effluent and to abate the effluent in a suitable abatement unit. Such an abatement unit may be a thermal abatement unit in which the effluent is heated and mixed with an oxidant to oxidize the effluent.

[0023] Silane may be expensive and difficult to obtain in the future. In addition, some electronic device manufacturing fabrication plants may be located in relatively remote locations where it is difficult or expensive to truck or pipe in reagents. It would be desirable to reuse these reagents so that only lesser amounts may need to be obtained from suppliers and lesser amounts may need to be treated as waste.

[0024] In one aspect, the present invention provides methods and apparatus for reclaiming hydrogen for reuse as a reagent in a substrate coating process. This may be accomplished by taking a stream of unused reagent from the substrate coating chamber and scrubbing it to remove impurities. The scrubbed unused reagent stream may then be passed through a cold trap or a refrigerated chiller to further purify the unused reagent stream. Next, the unused reagent stream may be passed through a dryer to remove water which may be present in the unused reagent stream. The unused reagent stream may then be passed back to a gas box from which it may be supplied to the substrate coating chamber as a reagent.

[0025] In another aspect, the present invention provides methods and apparatus for reclaiming hydrogen for reuse as a reagent in a substrate coating process, and for reclaiming silicon for use in the manufacture of silane, which silane may then be used as a reagent in the substrate coating process. This may be accomplished by taking a stream of unused reagent from the substrate coating chamber and passing it through a silicon filter to remove silicon, silane, di-silane, tri-silane, and poly-silane from the unused reagent stream. In addition, to remove any dopants which may be present in the unused reagent stream, the unused reagent stream may be passed through a dopant filter, or an adsorption or absorption separation matrix. The unused reagent stream that has been passed through the filters may then consist primarily of hydrogen which may be passed to a gas box from which it may be sent to the substrate coating chamber for reuse.

[0026] FIG. **1** is a schematic drawing of an substrate coating system **100** of the present invention useful for reclaiming and reusing hydrogen as a reagent in a substrate coating process. System **100** may include a substrate coating chamber **102** which may be used to coat substrates. For example, in the production of solar panels, it is common to coat a substrate such as glass with silicon to form a polysilicon coating on the glass. Substrates other than glass may be used, for example, metals, films, polymers, etc. System **100** may be used in coating processes other than the production of solar panels.

[0027] Substrate coating chamber **102** may be connected through conduit **104** and throttle valve **106** to blower package **108**. Blower package **108** may include low pressure water cooled blowers, although non-water cooled blowers may be used. The blowers may be lower tolerance blowers and may provide the benefits of less energy being needed to run the blowers and less heat being transferred to the gasses being moved by the blowers. In embodiments wherein more than one blower (optionally water cooled) may be used in blower package **108**, the blowers may be staged so as to increase the pressure of the recycle stream while imparting a reduced amount of heat to the recycle stream. Any blowers or pumps which can increase the pressure of the recycle stream to, for example, between about 10 to about 40 p.s.i., about 20 to about 30 p.s.i. or about 10 to about 20 p.s.i., may be used. Other higher and lower pressures may be used. The blowers may reduce or eliminate the transmission of any back pressure waves from downstream of the blower package **108** to upstream of the blower package **108**.

[0028] Blower package **108** may be connected through conduit **110** to wet scrubber **112**. Scrubber **112** may be, for example, a bubble tower, burr saddle, packed bed tower, or scrubbing tower. Any suitable wet scrubber may be used.

[0029] Scrubber **112** may be connected through conduit **114** to cold trap **116**. Cold trap **116** may include one or more refrigerated plates or other surfaces upon which gases which are to be removed from a gas stream may condense. The cold trap **116** may be adapted to be isolated and bypassed to facilitate maintenance.

[0030] Scrubber **112** and cold trap **116** may be connected to a water treatment unit (not shown) through conduit **118**. Cold trap **116** may be connected through conduit **120** to dryer **122**. The dryer **122** may be a molecular sieve dryer, or any other suitable dryer. The dryer **122** may be a single or a multiple bed dryer.

[0031] The dryer **122** may be connected through conduit **124** to blower **126**. Blower **126** may be similar to a blower used in the blower package **108**. Blower **126** may be connected through conduit **128** to oil filter **130**. Oil filter **130** may be used to trap any oil, contaminant, lubricant reaction products, and or any other high vapor pressure material which may be imparted to the reagent stream from blower stack **126**.

[0032] Oil filter **130** may be connected through conduit **132** to gas box **134**. The gas box **134** may be used to mix reagent and other gases for introduction through conduit **136** into substrate coating chamber **102**. The gas box **134** may be configured such that it is connected to reagent sources (not shown) and other gas sources (not shown). The reagent and other gases may be introduced into the gas box through mass flow controllers (not shown) so that precise mass flow rates of reagent and other gases may be introduced.

[0033] The substrate coating chamber **102** may also be connected to pump stack **138** through conduit **140** and or isolation valve **142**. The pump stack **138** may be connected through conduit **144** to abatement tool **146**.

[0034] The abatement tool **146** may be a burn wet abatement tool, or an electro thermal abatement unit, etc. Any abatement tool which is effective to abate chamber cleans may be used. The abatement tool **146** may be connected through conduit **148** to a house exhaust system (not shown), further abatement treatment on (not shown), or to the atmosphere.

[0035] Chamber pressure control gauge **150** may be connected to substrate coating chamber **102** and may also be connected to throttle valve **106** through communication line **152**.

[0036] In operation, the substrate coating chamber **102** may be operated in two modes. In a first mode, the substrate coating chamber **102** may perform a coating process whereby a substrate is coated with, for example, silicon. In a second mode, the substrate coating chamber **102** may be cleaned with a plasma, such as a fluorine plasma.

[0037] The following description of the operation of system **100** uses a silicon coating on a substrate as an example. It should be understood, however, that the invention is not limited to coating silicon on a substrate, but, rather, may be used in any electronic device manufacturing process where a reagent may pass unused through a process chamber. Examples include deposition applications for solar panels, liquid crystal displays, organic light emitting diodes, film, and nanomanufacturing, etc. In addition, the invention may be used for process chambers which may be used to etch patterns to remove unwanted materials and/or to clean surfaces, etc.

[0038] In the first mode, the deposition mode, the gas box **134** may supply hydrogen and silane gases to the substrate coating chamber **102**. During the coating process, the pressure in the substrate coating chamber **102** may be regulated by pressure gauge **150** and a combination of the throttle valve **106**, the pump stack **108**, and gas additions to the process chamber **102** from the gas box **138**. The blower package **108** may provide a source of vacuum through conduit **104**. Thus, during the coating process, an excess hydrogen and silane gas stream may be evacuated by blower package **108** from the substrate coating chamber **102** through conduit **104**, throttle valve **106** and conduit **110**, and passed into scrubber **112**. The unused hydrogen and silane reagents may contact water in scrubber **112** which may have the effect of removing silane, di-silane, tri-silane, and poly-silane from the gas stream. In addition, scrubber **112** may remove dopants which may exist in the gas stream. The silane, di-silane, tri-silane, poly-silane, and dopants may exit the scrubber in scrubber medium through conduit **118**. The remaining gas stream may then pass through conduit **114** into cold trap **116**. The cold trap **116** may have the effect of removing any remaining particles, water, silane, di-silane, tri-silane, poly-silane, and dopants, which may remain in the gas stream. The gas stream may pass from the cold trap **116** through conduit **120** into dryer **122**, where the gas stream may be dried to less than about 2 ppm water. Blower **126** may then motivate the gas stream to move from dryer **122** through conduits **124**, **128** and oil filter **130** where any oil or other high molecular weight and/or high vapor pressure species which may have been imparted to the gas stream from blower **126** and/or blower **108** may be removed. At this stage, the gas stream may be a high purity stream of hydrogen gas which may then be inserted into gas box **134** for reuse as a reagent in the substrate coating process conducted in substrate coating chamber **102**.

[0039] In the second mode, the cleaning mode, the substrate coating chamber may be cleaned with a plasma from a remote plasma source (not shown). This plasma clean may be motivated by pump stack **138** to move through conduit **140**, isolation valve **142** and conduit **144** into abatement tool **146**, where the plasma clean may be abated. From the abatement tool **146**, the abated plasma clean may pass through conduit **148** into a house scrubber (not shown), further abatement (not shown), or to the atmosphere.

[0040] FIG. **1**A is a schematic drawing of an alternative configuration of the substrate coating system **100** of FIG. **1**, substrate coating system **100**A. System **100**A may be similar to system **100** of FIG. **1** with the exception of the connection between the blower package **108** and the substrate coating chamber **102**, and the inclusion of a control system. Instead of the blower package **108** being connected directly to the substrate coating chamber **102**, as depicted in FIG. **1**, the blower package **108** may be connected through conduit **154** and three way valve **156** to conduit **140**. Conduit **140** may be a vacuum line which connects pump stack **138** to the substrate coating chamber **102**. Controller **158** may be connected through signal lines **162** the gas box **134**, the substrate coating chamber **102**, and the three way valve **156**.

[0041] In operation, system **100**A may operate similarly to system **100** of FIG. **1**, with the exception that during the coating or deposition mode, unused reagent gases may not pass into conduit **104** as the reagent gases may in the system **100** of FIG. **1**. Instead, the reagent gasses may pass into conduit **140**, and then be diverted by valve **156** through conduit **154** into blower package **108**. During the chamber clean mode, the valve **156** may be configured such that the chamber clean may pass through conduit **140** into pump stack **138**.

[0042] The controller **158** may determine whether the substrate coating chamber **102** is in the clean mode or in the deposition mode, and may appropriately configure three way valve **156**.

[0043] FIG. **2** is a schematic drawing of a substrate coating system **200** depicting another embodiment of the present invention. System **200** may include a substrate coating chamber **202** may be used to coat substrates. The substrate coating chamber **202** may be similar to the substrate chamber **102** of FIG. **1**. The substrate coating chamber **202** which may be connected through conduit **204** and throttle valve **206** to blower package **208**.

[0044] Blower package **208** may be similar to blower package **108** of FIG. **1**.

[0045] Blower package **208** may be connected through conduits **210**, **210'** and oil filters **212**, **212'** to separation systems **214**, **214'**. Oil filters **212**, **212'** may be similar to oil filter **130** of FIG. **1**. Although two separation systems **214**, **214'** are shown in FIG. **2**, it is to be understood that fewer or more separation systems may be used (e.g., 1, 3, 4, etc.).

[0046] Separation system **214** may include isolation valves **216**, **218**; dopant separator **220**; and silicon separator **222**. Isolation valves **216**, **218** may be used to isolate separation system **214** from system **200**. Dopant separator **220** may be an absorption separation matrix or an adsorption separation matrix. Alternatively, the dopant separator **220** may be replaced with a dopant filter (not shown). Similarly, the silicon separator **222** may be an absorption separation matrix or an adsorption separation matrix, or, alternatively, silicon separator **222** may be a silicon filter. A suitable filter may be a honeycomb ceramic matrix which is coated with silicon. The ceramic may be an yttria doped alumina. Separation system **214'** may be similar to separation system **214**.

[0047] Separation systems **214**, **214'** may be connected to blower **224**. Blower **224** may be connected through conduit **226** and oil filter **228** to gas box **230**. Gas box **230** may be connected through conduit **232** to substrate coating chamber **202**.

[0048] Substrate coating chamber **202** may also be connected through conduit **234** and isolation valve **236** to pump stack **238**. Pump stack **238** may be connected through conduit **240** to abatement tool **242**. Abatement tool **242** May be connected through conduit **244** to a house exhaust system (not shown), further abatement treatment (not shown), or to the atmosphere, etc.

[0049] Pressure gauge **246** may be connected to substrate coating chamber **202** and two throttle valve **206** by signal line **248**.

[0050] Although not shown, system **200** may be modified in a way similar to the way system **100** may be modified to

form system **100**A. Such a modification would replace isolation valve **236** with a three way valve, which would be adapted to divert gas flow between the pump stack **238** and the blower package **208**, depending upon whether the chamber was in a clean mode or a deposition mode, respectively. A controller such as the controller in system **100**A may also be used.

[0051] In operation, substrate coating chamber **202** may operate similarly to substrate coating chamber **102** of FIG. **1**, with the exception that in the deposition mode the unused reagents may not be passed through a wet scrubber, a cold trap, and a dryer, as they are in system **100** of FIG. **1**.

[0052] Instead, the unused reagents (and any dopants) may be passed from blower package **208** through conduits **210**, **210'**, through oil filters **212**, **212'** and into separation systems **214**, **214'**.

[0053] Separation systems **214**, **214'** may remove dopants from the unused reagent gas stream with dopant separators **220**, **220'**, which, as described above, may be absorption or adsorption separation matrices. The dopants may be collected, separated if necessary, and reused as dopants.

[0054] Separation systems **214**, **214'** may remove silicon compounds from the unused gas stream using silicon separation units **222**, **222'**. Silicon separators **222**, **222'** may remove silicon, silane, di-silane, tri-silane, and poly-silane through mechanisms of absorption, adsorption, and/or filtration. The silicon, silane, di-silane, tri-silane, and poly-silane which may be removed from the unused reagent gas stream may be collected and sent, or sent directly, to a silane manufacturing unit, which may supply silane to the gas box **230** for use as a substrate in substrate coating chamber **202**.

[0055] The net result of the unused reagent gas stream passing through separation systems **214**, **214'** may be that the unused reagent gas which flows from the separation systems **214**, **214'** into blower **224** may include high purity hydrogen gas. The high purity hydrogen gas may flow through conduit **226** and oil filter **228** (where any oil or other high molecular weight contaminant introduced into the hydrogen gas by blower **224** may be removed), and into gas box **230**.

[0056] The remainder of the system **200** of FIG. **2** may operate similarly to the system **100** of FIG. **1**.

[0057] FIG. **3** is a schematic drawing depicting a substrate coating system **300** of the invention which includes a co-generation apparatus. System **300** may include gas box **302** which may be connected through conduit **304** to substrate coating chamber **306**. The substrate coating chamber **306** may be similar to the substrate coating chambers discussed above with reference to the previous figures. Substrate coating chamber **306** may be connected through conduit **308** to pump stack **310**. The pump stack **310** may be connected through conduit **312** to abatement tool **314**. Abatement tool **314** may be connected through conduit **316** to steam generator **318**. The steam generator **318** may be connected through conduit **322** to cooling tower **324**. The steam generator may also be connected to a power grid or storage unit through electrical wire **320**. The cooling tower **324** may be connected through conduit **326** to the abatement tool **314**. Abatement tool **314** may be connected through conduit **328** to a house exhaust (not shown), further abatement treatment (not shown), or to the atmosphere. Pressure gauge **330** may be connected to the substrate coating chamber **306** and to the throttle valve **332** through signal line **334**.

[0058] In operation the gas box **302** may provide reagent and other gases through conduit **304** to the substrate coating chamber **306**. The substrate coating chamber **306** may operate similarly to the substrate coating chambers described with respect to the previous figures. During both deposition and chamber clean modes, effluent from the substrate coating chamber which may contain high levels of hydrogen and silane, may be evacuated from the substrate coating chamber through conduit **308** and throttle valve **332** by pump stack **310**. The effluent may then flow through conduit **312** into abatement tool **314** where the effluent may be burned. In addition, the burned effluent may be contacted with cooling water in the abatement tool **314** to produce steam which may be exhausted through conduit **316** into steam generator **318**. The steam generator **318** may generate electricity which may pass through electrical wire **320** to a power grid (not shown) or to an electrical storage device (not shown). The steam generator **318** may send hot water (which may include condensed steam) and steam through conduit **322** to cooling tower **324**, were the hot water and steam may be cooled to form cooled water. The cooled water may be returned from the cooling tower **324** through conduit **326** to the abatement tool **314**, where the cooled water may be used to cool the burned effluent and regenerate steam. Effluent from the abatement tool **314**, which effluent may include oxidized unused reagents and oxidized chamber clean, may be sent through conduit **328** to a house exhaust (not shown), further abatement treatment (not shown), or to the atmosphere.

[0059] The operating pressure inside of the substrate coating chamber may be controlled by a combination of the pressure gauge **330**, the throttle valve **332**, the pump stack **310**, and the addition of gases from the gas box **302**.

[0060] FIG. **4** is a schematic depiction of a substrate coating system **400**. System **400** may be similar to the system **100** of FIG. **1**, with the following exceptions. In system **400**, the oil filter **130** may not be connected through conduit **132** to gas box **134** as it is in the system **100** of FIG. **1**. Instead, the oil filter **130** may be connected through the conduit **132** to separation unit **402**. The separation unit **402** may be a membrane separator which may be adapted to separate hydrogen gas from an inert gas. Any suitable separator may be used. The separation unit **402** may be connected through conduit **404** to the gas box **134** and through conduit **406** to inert gas source **408**. The inert gas source **408** may be connected through the conduit **410** to the gas box **134**.

[0061] In operation, the system **400** may operate similarly to the operation of system **100** of FIG. **1**, with the following exceptions. In the system **400**, inert gas may be introduced into the gas box **134** from the inert gas source **408** through the conduit **410**. The inert gas may be nitrogen, helium, argon, etc. or any other suitable inert gas. The inert gas may be used to cool the substrate coating chamber **102**. An additional benefit may be more efficient utilization of reagents such as silane and hydrogen. The inert gas may pass with the unused reagents through the system until the inert gas enters conduit **132** with otherwise highly pure hydrogen gas. The inert gas/hydrogen gas mixture may then enter separation unit **402** which may separate the hydrogen gas from the inert gas. The hydrogen gas may then pass from the separation unit **402** through the conduit **404** and into the gas box **134**. The inert gas may pass from the separation unit **402** through the conduit **406** into the inert gas box **408**, from which it may be sent through the conduit **410** into the gas box **134**.

[0062] FIG. **5** is a schematic depiction of a substrate coating system **500**. System **500** may be similar to the system **200** of FIG. **2**, with the following exceptions. In system **500**, the oil

filter **228** may not be connected through the conduit **226** to the gas box **230** as it is in system **200** of FIG. **2**. Instead, the oil filter **228** may be connected through conduit **502** to separation unit **504**. The separation unit **504** may be similar to the separation unit **402** of FIG. **4**. The separation unit **504** may be connected through conduit **506** to the gas box **230**. The separation unit **504** may also be connected through the conduit **508** to inert gas source **510**. The gas source **510** may be connected through conduit **512** to gas box **230**.

[0063] In operation, the system **500** may operate similarly to the operation of the system **200** of FIG. **2**, with the following exceptions. In the system **500**, inert gas may be introduced into the gas box **134** from the inert gas source **510** through the conduit **512**. As in the system **400** of FIG. **4**, the inert gas may be nitrogen, helium, argon, etc. or any other suitable inert gas. The inert gas may have the same effects on the system **500** as the inert gas has on the system **400** of FIG. **4**. As in the system **400**, the inert gas may pass with the unused reagents through the system until the inert gas enters the conduit **502** with otherwise highly pure hydrogen gas. The inert gas/hydrogen gas mixture may then enter the separation unit **504** which may separate the hydrogen gas from the inert gas. The hydrogen gas may then pass from the separation unit **504** through the conduit **506** into the gas box **230**. The inert gas may pass from the separation unit **504** through the conduit **508** into the inert gas source **510** from which the inert gas may be sent through the conduit **512** into the gas box **230**.

[0064] The foregoing description discloses only exemplary embodiments of the invention. Modifications of the above disclosed apparatus and methods which fall within the scope of the invention will be readily apparent to those of ordinary skill in the art. For example, in the systems **400** and **500**, the unused reagent gas may pass through a vacuum line and three-way valve as the unused reagent gases do in system **100**A. Such modified systems may have control systems which divert effluent from the process chamber to either be recycled or abated depending upon whether the process chamber is in a deposition or in a chamber clean mode.

The invention claimed is:

1. A substrate coating system comprising:
a substrate coating chamber;
a gas box connected to the coating chamber and adapted to provide reagent gases to the coating chamber; and
a reagent reclaim system connected to the substrate coating chamber and the gas box, wherein the reagent reclaim system comprises:
a wet scrubber connected to the coating chamber;
a polisher connected to the scrubber; and
a dryer connected to the polisher and the gas box.

2. The substrate coating system of claim **1** further comprising a blower package located between the substrate coating chamber and the scrubber.

3. The substrate coating system of claim **1** wherein the polisher comprises a cold trap.

4. The substrate coating system of claim **1** wherein the polisher comprises a refrigerated chiller.

5. The substrate coating system of claim **1** wherein the dryer comprises a molecular sieve dryer.

6. The substrate coating system of claim **1** further comprising a blower and an oil filter located between the dryer and the gas box.

7. The substrate coating system of claim **1** further comprising a pump stack connected to the substrate coating chamber and an abatement tool connected to the pump stack.

8. The substrate coating system of claim **7** wherein the scrubber is connected to the coating chamber through a vacuum line which connects the pump stack to the substrate coating chamber.

9. A substrate coating system comprising:
a substrate coating chamber;
a gas box connected to the coating chamber and adapted to provide reagent gases to the coating chamber; and
a reagent reclaim system connected to the substrate coating chamber and the gas box, wherein the reagent reclaim system comprises:
a reagent filter; and
a dopant filter.

10. The substrate coating system of claim **9** wherein the reagent filter comprises one of a silicon filter, an adsorption separation matrix and an absorption separation matrix.

11. The substrate coating system of claim **10** wherein the reagent filter is heated.

12. The substrate system of claim **9** wherein the dopant filter comprises an adsorption separation matrix and an absorption separation matrix.

13. The substrate system of claim **12** wherein the dopant filter is heated.

14. The substrate coating system of claim **9** further comprising a blower package located between the reagent filter and the substrate coating chamber.

15. The substrate coating system of claim **9** further comprising a blower and an oil filter located between the dopant filter and the gas box.

16. A method of operating a substrate coating system comprising:
supplying more than one reagent to a substrate coating chamber;
coating a substrate in the substrate coating chamber;
exhausting unused reagents from the substrate coating chamber; and
reclaiming a reagent for reuse as a reagent in the substrate coating chamber.

17. The method of claim **16** wherein reclaiming the reagent for reuse as a reagent in the substrate coating chamber comprises scrubbing the unused reagents to remove impurities.

18. The method of claim **17** further comprising using a cold trap to remove impurities which remain in the unused reagents following the scrubbing.

19. The method of claim **17** further comprising drying the scrubbed unused reagents.

20. The method of claim **19** further comprising supplying the dried, scrubbed, unused reagents to a gas box which is adapted to supply more than one reagent to the substrate coating chamber.

21. The method of claim **16** wherein reclaiming a reagent for reuse as a reagent in the substrate coating chamber comprises filtering silicon from the unused reagents.

22. The method of claim **21** further comprising filtering dopants from the unused reagents.

23. The method of claim **21** further comprising using the filtered silicon to manufacture silane for use as a reagent in the substrate coating chamber.

24. The method of claim **21** further comprising sending the unused reagents from which silicon has been filtered to a gas box for reuse as a reagent in the substrate coating chamber.

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