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(54) **AIR PURIFICATION SYSTEM AND METHOD FOR MAINTAINING NITROGEN AND OXYGEN RATIOS WITH REGENERATIVE PURIFICATION UNITS**

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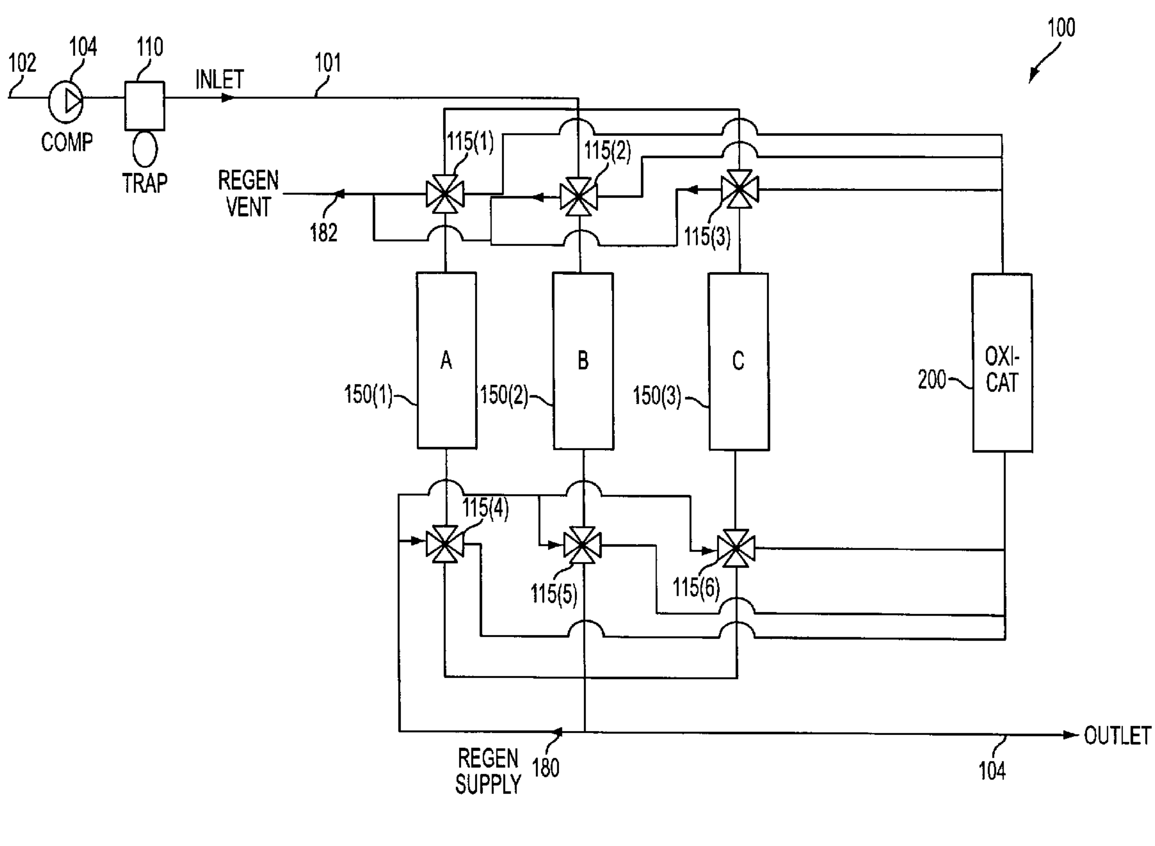
(57) **ABSTRACT**

The invention teaches a purification system which uses a series of operations, in a single unit, to purify air, while extending the life of the purification units. Air is passed through a coarse water trap to remove liquid. The semi-dry air, which is usually less than 3000 ppm of water vapor, is then passed through adsorbers, which remove the remaining moisture and all the carbon dioxide in a purification process. The drying of the air before passing it through the adsorbers allows for greatly improved efficiency of air purification and extends the life of both the oxygen catalyst and the adsorption columns. The present invention also flows the air to be purified through adsorption columns twice, before and after passing the air through an oxygen catalyst unit. The oxidizing catalyst, which is heated to a temperature of approximately 300 degrees centigrade, converts carbon monoxide and hydrocarbons to H_2O and CO_2 The newly converted H_2O and CO_2 are then removed by the second pass through a second adsorption column in the second flow direction or downstream. The flows of air are then rotated with a third column, which is thermally regenerating with the facilitation of a regeneration air supply from the purified air.



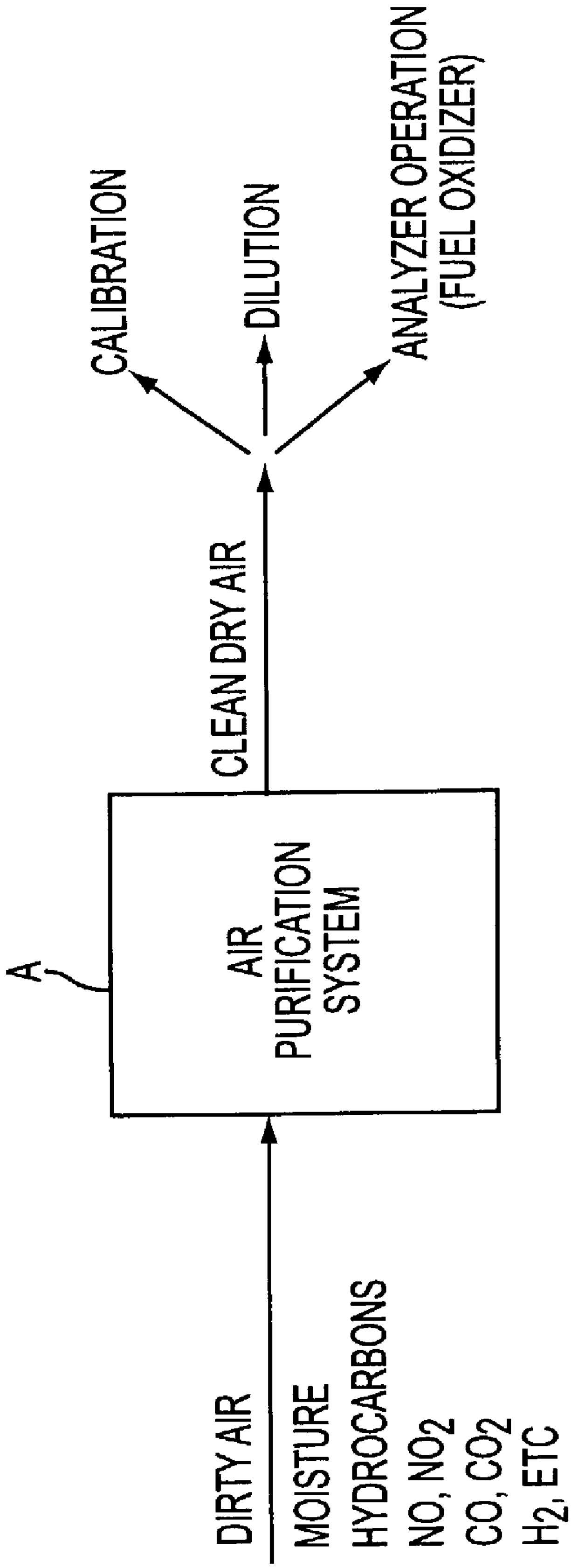


FIG. 1 (PRIOR ART)

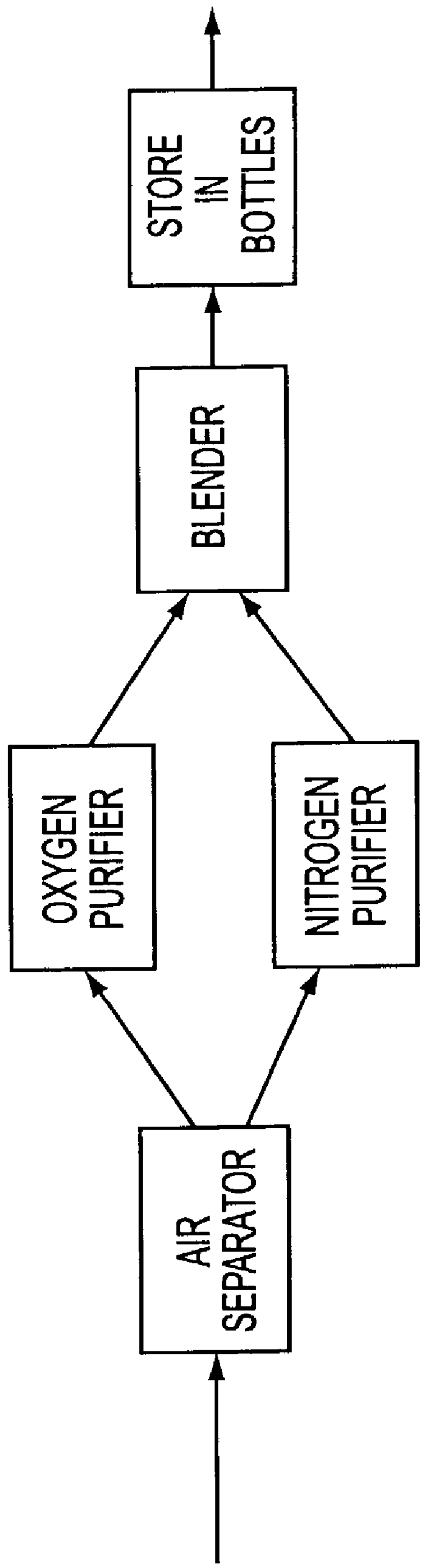


FIG. 2
(PRIOR ART)

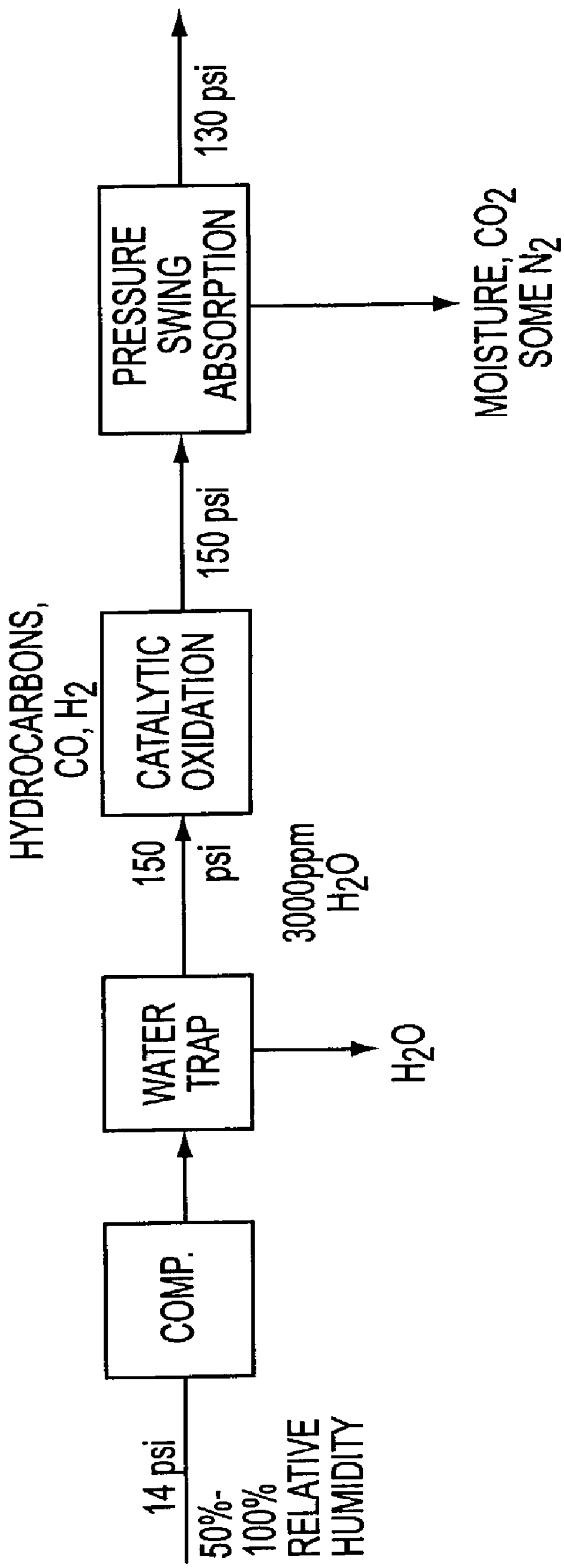


FIG. 3
(PRIOR ART)

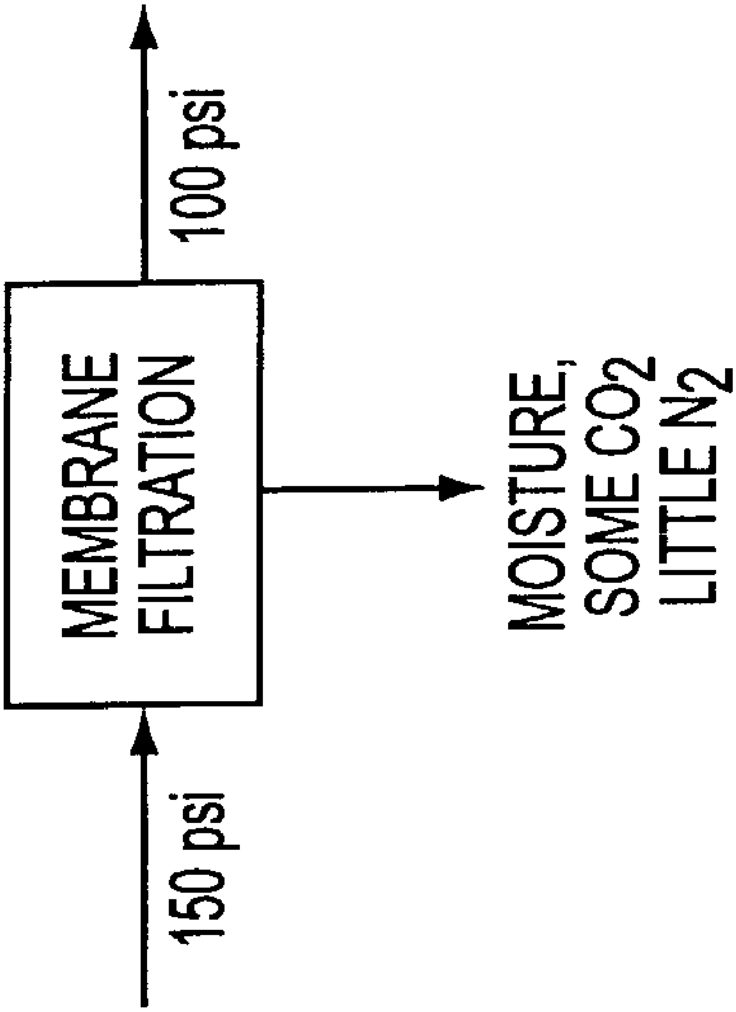


FIG. 4
(PRIOR ART)

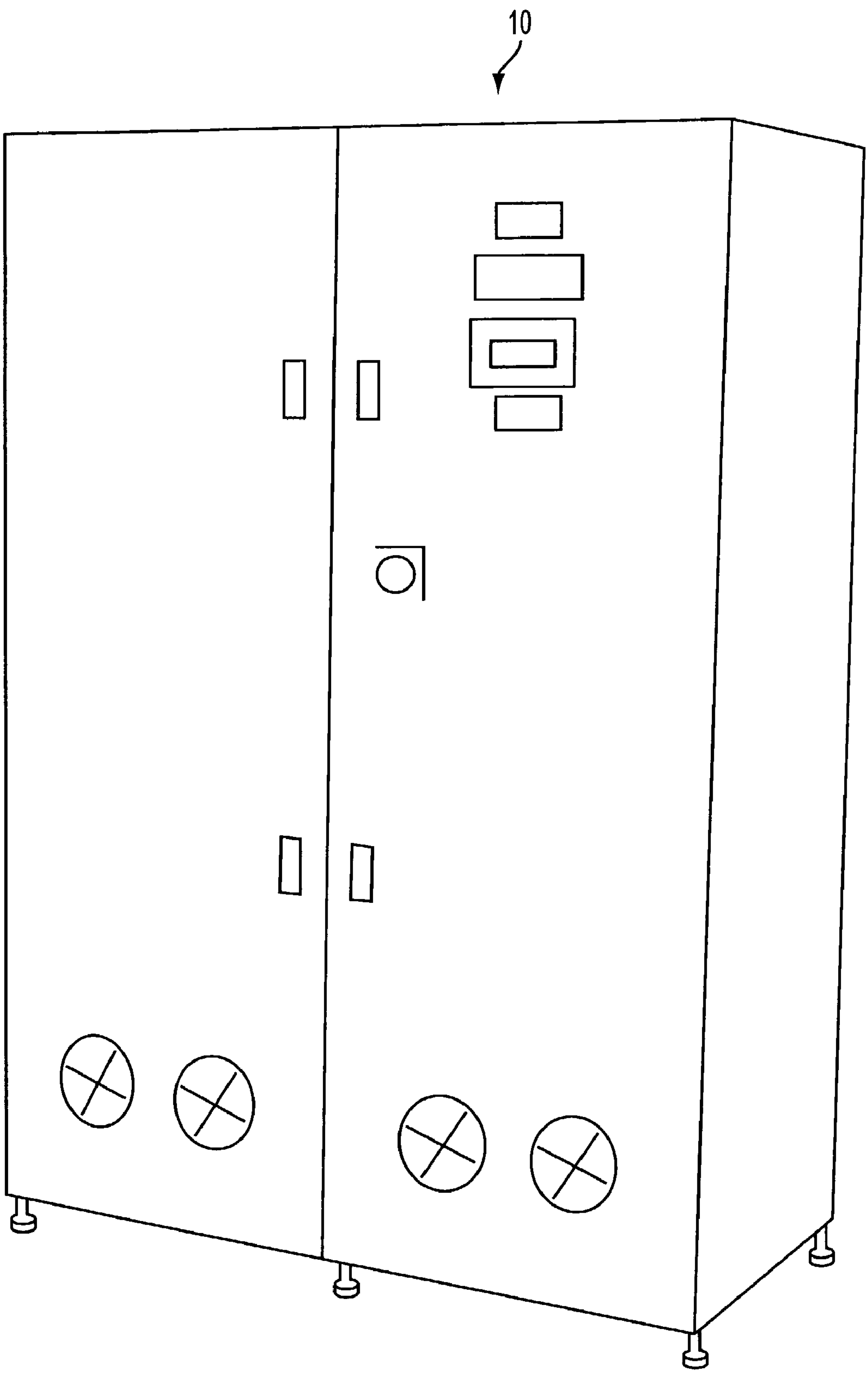


FIG. 5

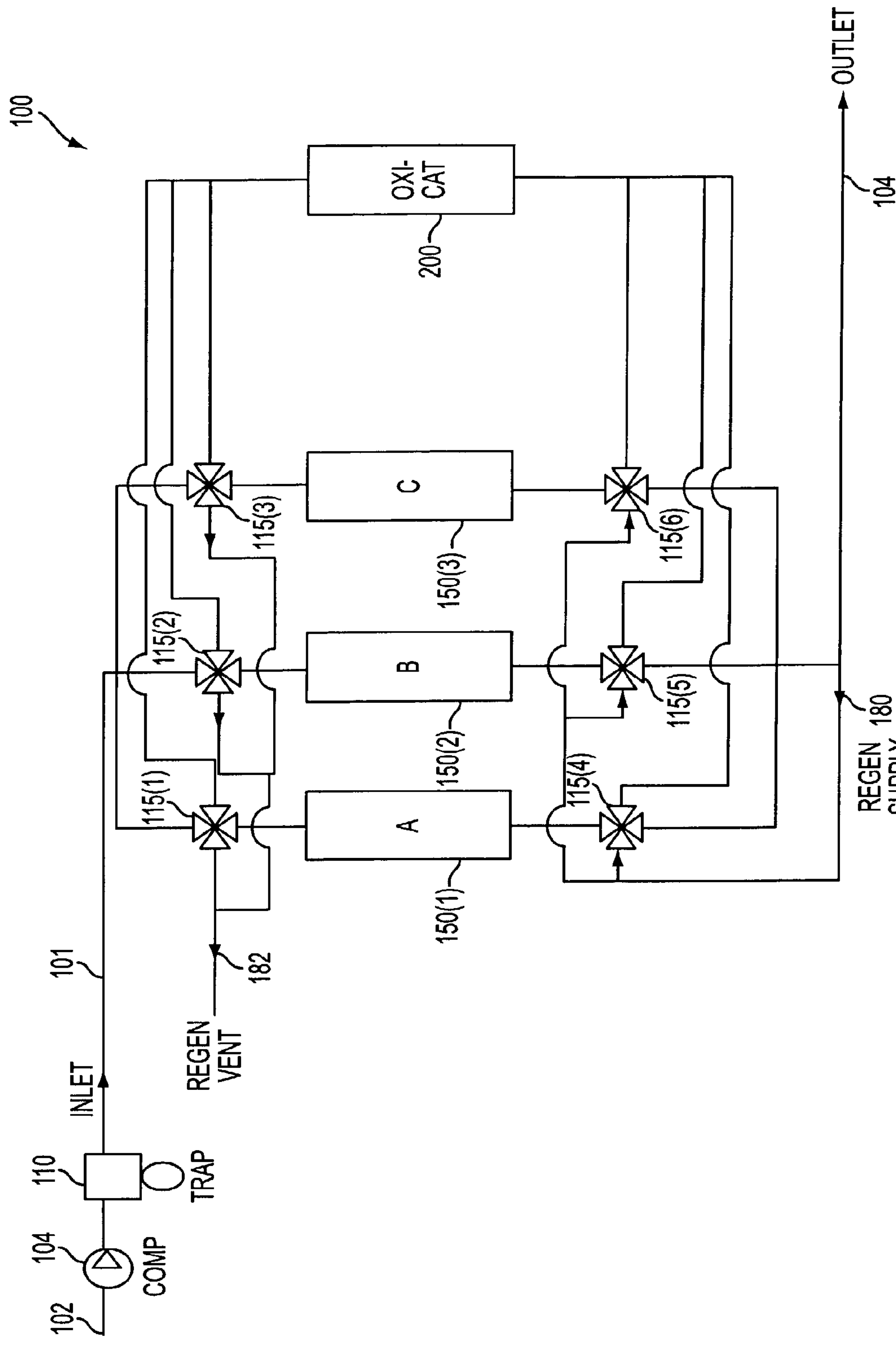

100
OUTLET
104
OXI-
CAT
200
C
B
A
115(1)
115(2)
115(3)
115(4)
115(5)
115(6)
150(1)
150(2)
150(3)
REGEN
SUPPLY
180
101
182
REGEN
VENT
INLET
110
TRAP
104
COMP
102

FIG. 6

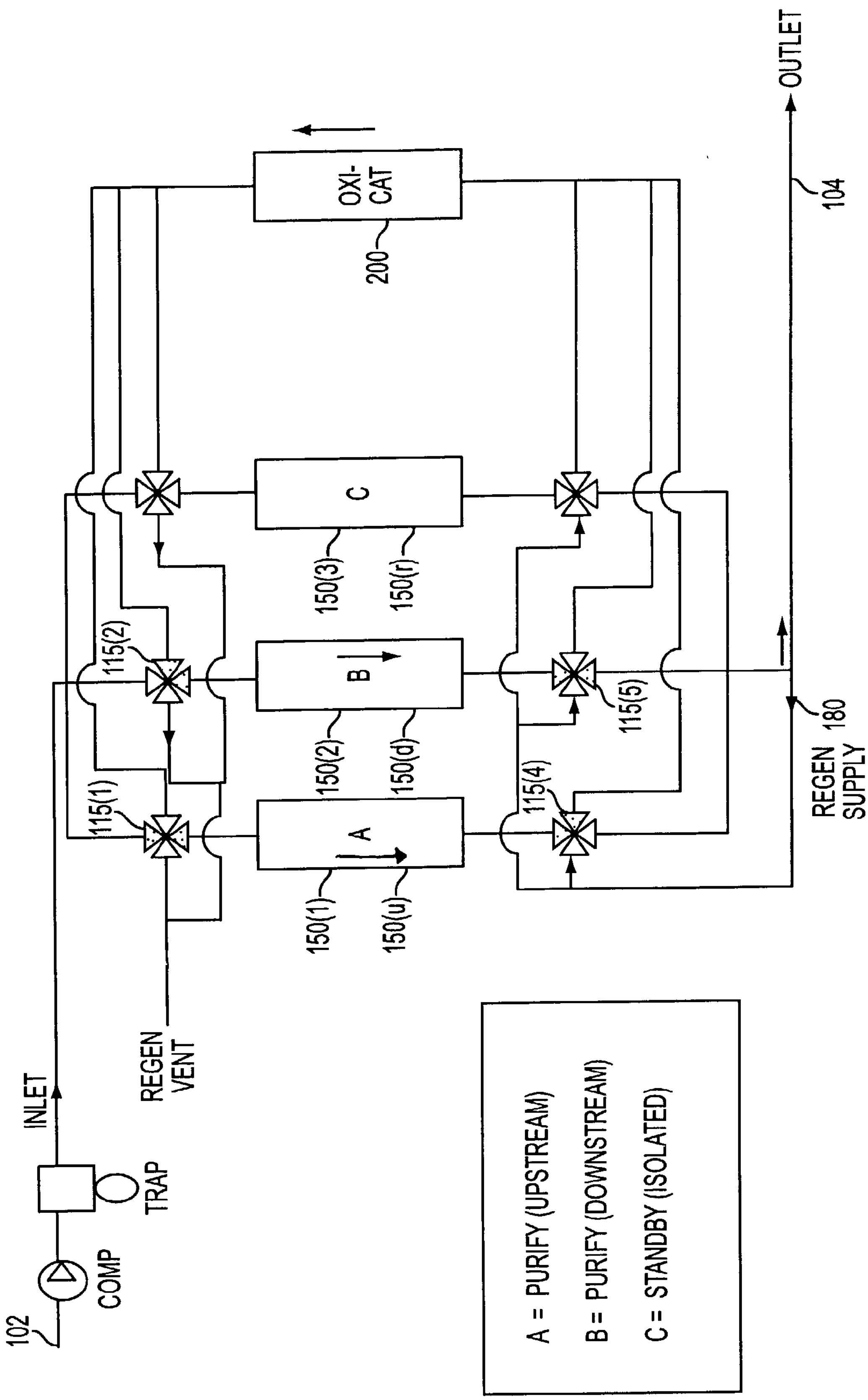

OUTLET
104
OXI-CAT
200
C
150(3)
150(r)
B
150(2)
150(d)
115(2)
A
150(1)
150(u)
115(1)
115(4)
115(5)
REGEN SUPPLY
180
REGEN VENT
INLET
TRAP
COMP
102
A = PURIFY (UPSTREAM)
B = PURIFY (DOWNSTREAM)
C = STANDBY (ISOLATED)

FIG. 7

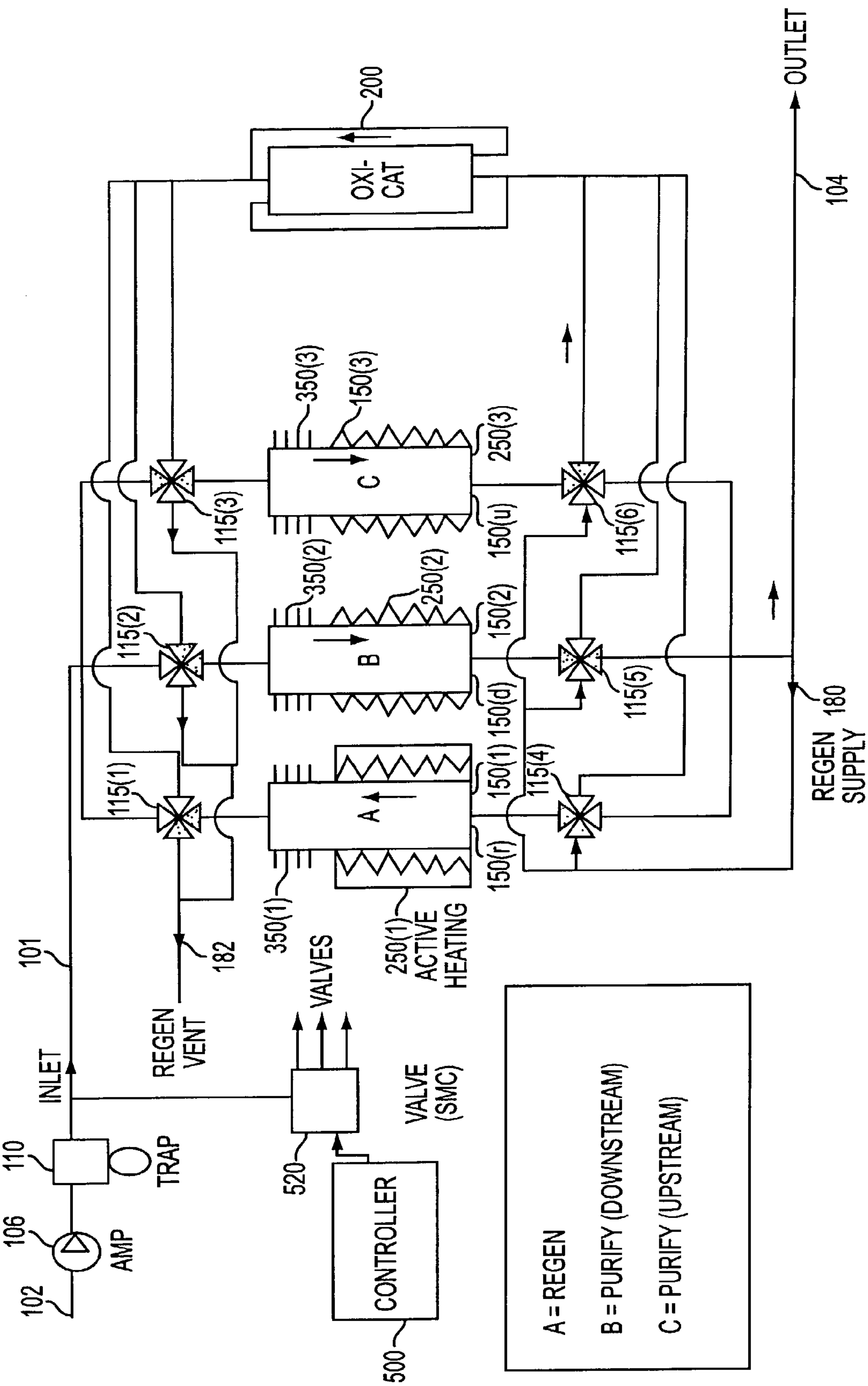

102
106
AMP
110
TRAP
INLET
101
REGEN VENT
182
VALVES
520
VALVE (SMC)
CONTROLLER
500
350(1)
250(1) ACTIVE HEATING
115(1)
115(2)
115(3)
115(4)
115(5)
115(6)
A
B
C
150(r)
150(1)
150(d)
150(2)
150(u)
150(3)
250(2)
250(3)
350(2)
350(3)
OXI-CAT
200
REGEN SUPPLY
180
104
OUTLET
A = REGEN
B = PURIFY (DOWNSTREAM)
C = PURIFY (UPSTREAM)

FIG. 8

P = PURIFY

R = REGEN

S = STANDBY

U = UPSTREAM

D = DOWNSTREAM

TRUTH TABLE
OPERATING MODES

A	B	C	t
P-U	P-D	S	1
R	P-D	P-U	2
S	P-D	P-U	3
P-D	R	P-U	4
P-D	S	P-U	5
P-D	P-U	R	6
P-D	P-U	S	7

FIG. 9

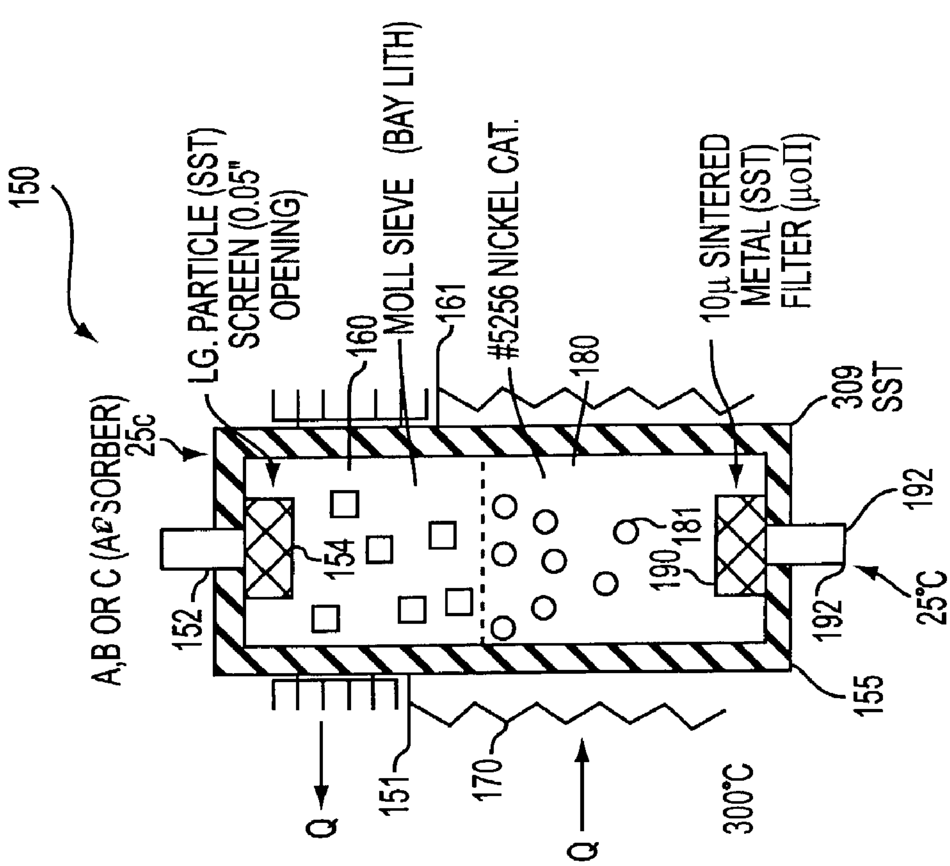

150
A,B OR C (ADSORBER)
25c
LG. PARTICLE (SST) SCREEN (0.05" OPENING)
160
MOLL SIEVE (BAY LITH)
161
#5256 NICKEL CAT.
180
10μ SINTERED METAL (SST) FILTER (μoΠ)
309
SST
152
154
190
181
192
192
25°C
155
151
170
Q
Q
300°C

FIG. 10

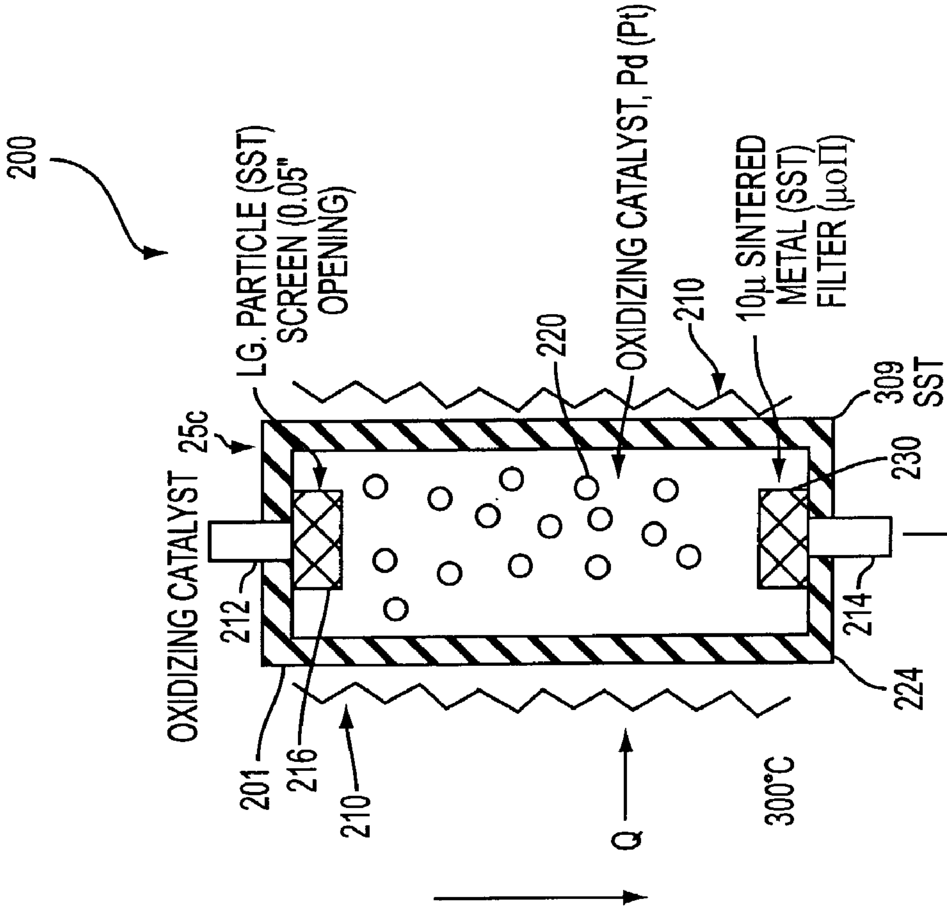

200
LG. PARTICLE (SST) SCREEN (0.05" OPENING)
OXIDIZING CATALYST, Pd (Pt)
10μ SINTERED METAL (SST) FILTER (μoII)
OXIDIZING CATALYST
25c
220
210
309 SST
230
AX
212
214
224
201
216
210
Q
300°C

FIG. 11

AIR PURIFICATION SYSTEM AND METHOD FOR MAINTAINING NITROGEN AND OXYGEN RATIOS WITH REGENERATIVE PURIFICATION UNITS

CLAIM OF PRIORITY TO RELATED DOCUMENTS

[0001] This application claims priority under 35 U.S.C. §119(e) to U.S. Provisional Application No. 60/335,193 filed Oct. 31, 2001, entitled AIR PURIFICATION SYSTEM AND METHOD FOR MAINTAINING NITROGEN AND OXYGEN RATIOS WITH REGENERATIVE PURIFICATION UNITS (Rabellino, et. al), which is herein incorporated by reference for all purposes.

FIELD OF THE INVENTION

[0002] The invention relates to air purification systems with regenerative purification filters in which the output air has a substantially similar ratio of normal nitrogen and oxygen air purified to 1 part per billion of impurity, in which the gases are not separated and recombined.

BACKGROUND OF THE INVENTION

[0003] Purified air is needed for a variety of applications, such as zero setting for analyzers, oxidizer gas for analyzers, and dilution air for emissions analysis. Increasingly lower standards for the quality of "normal" air requires improved quality "zero," oxidizer, and dilution air.

[0004] **FIG. 1** is a depiction of a generic description of prior art air purification. Purified air is currently available mainly in limited quantity in bottled gas form from companies that supply both pure oxygen and nitrogen as well. The process of purifying air, as opposed to purifying a single type of gas, is usually far more expensive and energy intensive because the air has to be broken down into the gas components of Nitrogen and Oxygen, each gas separately purified, and then recombined in the bottle gas form. Such a system is depicted in prior art **FIG. 2** and creates a high energy and monetary cost for purified air. **FIG. 3** represents prior art method pressure swing adsorption and will be detailed below. **FIG. 4** represents the membrane filter method, and is also well known to those skilled in the art. Both of the methods depicted in **FIGS. 3 and 4** can severely affect the nitrogen and oxygen ratios of purified air resulting in unusable purified air for the purposes mentioned above.

[0005] For example, U.S. Pat. No. 5,931,022 to Deng, et. al. and assigned to BOC of Murray Hill, N.J., and incorporated herein by reference, teaches a way to regenerate the alumina thermal purification units by keeping them 180 degrees in phase. However, this system is limited because it only teaches how to remove carbon dioxide from air. This system also teaches the pressure swing adsorption method of impurity remove (herein PSA). As stated above, PSA has the drawback that the more aggressively the carbon dioxide is removed from the air to be purified, the more the air is at risk for a significant reduction in Nitrogen levels. The reduction in Nitrogen levels changes the Nitrogen to Oxygen ratio and makes the resulting purified air less suitable for the uses of calibration, analysis, and dilution. The details of the actual PSA method are well known to those skilled in the are of gas purification and do not need to be detailed here.

[0006] What is needed is a system in which purified air is created from normal air without the cost and energy expense of breaking the air into its component gases. What is also needed is an air purification system in which the oxygen and nitrogen ratios are maintained in order to provide purified air which is usable for calibration and other purposes.

[0007] Furthermore, it is desirable and cost effective to have such a purification system in which the purification units or adsorbers can regenerate themselves automatically, eliminating the need to replace the purification units.

[0008] Additionally, it is desirable to have an ability to regenerate the adsorption units without having to remove the units to permit the uninterrupted operation of the air purifiers. Finally, it is desirable to treat the air before purification, such that the purification is performed more efficiently and the life of the adsorption units and the oxygen catalyst units are extended.

SUMMARY OF THE INVENTION

[0009] The present invention provides the ability of a single unit to provide a purified air supply, where the ratio of N_2 to O_2 is unaltered, where the presence of H_2, sulfur containing compounds, water, carbon dioxide THC and NOX are removed to a concentration below 1 part per billion.

[0010] The purification system of the present invention uses a series of operations, in a single unit, to purify air. Air can be supplied from either the facility or an on-board oilless compressor. The compressed air is passed through a coarse water trap to remove liquid. The semi-dry air, which is usually less than 3000 ppm of water vapor, is then passed through adsorbers, which remove the remaining moisture and all the carbon dioxide in a purification process. The drying of the air before passing it through the adsorbers allows for greatly improved efficiency of air purification and extends the life of both the oxygen catalyst and the adsorption columns.

[0011] The present invention also flows the air to be purified through adsorption columns twice, before and after passing the air through an oxygen catalyst unit. The double adsorption process is generally described in a preferred embodiment as being in two different "flow directions," or "upstream" and "downstream" respectively. The oxidizing catalyst, which is heated to a temperature of approximately 300 degrees centigrade, converts carbon monoxide and hydrocarbons to H_2O and CO_2 The newly converted H_2O and CO_2 are then removed by the second pass through a second adsorption column in the second flow direction or downstream. The invention uses an adsorption column, which operates in an upstream manner in order to remove moisture and carbon dioxide, but also significantly improves the life of the oxidizing catalyst, and an adsorption column that removes further CO_2, water and NOX when purifying in a downstream function.

[0012] Furthermore, the present invention teaches thermal regeneration of adsorption units in a rotating fashion, by creating a rotating control of the flow of air, such that one adsorption unit is always regenerating while one is purifying in a upward flow and another is purifying in a downward flow. This process results in a system in which the adsorption units require significantly less maintenance. The purified air leaving the downstream adsorption column is both directed to an outlet and to a regeneration source supply. The regeneration supply of purified air is then directed to flow "backward" through the regenerating adsorption column. The adsorption column is heated creating conditions for regeneration of the column under low pressure. The re-contaminated air is then flowed out of the system through a regeneration vent.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] **FIG. 1** is an illustration of the prior art process of air purification;

[0014] **FIG. 2** is an illustration of the prior art process of separating gases and recombining them;

[0015] **FIG. 3** is the prior art process of pressure swing adsorption method for air purification;

[0016] **FIG. 4** is the prior art process of the membrane filtration process of air purification;

[0017] **FIG. 5** is a container for the present invention;

[0018] **FIG. 6** is a system diagram of an embodiment of the present invention in the inactive state;

[0019] **FIG. 7** is a system diagram of the embodiment of the present invention in **FIG. 6** with one purifier purifying in a first flow direction (upstream), one purifying unit purifying unit in a second flow direction (downstream) and one purifying unit inactive;

[0020] **FIG. 8** is a system diagram of the embodiment of the present invention in **FIG. 6** with one purifier purifying upstream, one purifying unit purifying unit downstream and one purifying unit regenerating;

[0021] **FIG. 9** is a sample flow/regeneration rotation cycle for adsorption units in an embodiment of the present invention with three purifying units;

[0022] **FIG. 10** is a sample purifying unit as used in an embodiment of the present invention;

[0023] **FIG. 11** is a sample oxygen catalyst unit used in an embodiment of the present invention.

GUIDE TO DEFINITIONS IN THE SPECIFICATION

[0024] The expressions "first flow direction" and "upstream" are interchangeable and generally mean the flow of the adsorption column to the oxygen catalyst unit, as are the expressions "second flow direction" and "downstream," and indicate the flow of air from the oxygen catalyst unit. As such, they describe the operation of the invention in a preferred embodiment and should not be considered limitations with regard to flow of air in an absolute direction, like upward, downward, west, away from the front etc., but are meant only to contrast the direction flow of air in the different adsorption columns in relation to the oxygen catalyst unit.

[0025] The expression "molecular sieve" is intended to apply to generic molecular sieves, and where indicated a brand or type of molecular sieve will be noted.

[0026] The expression "purification unit" is a generic descriptive term for the adsorption column unit as implemented in a preferred embodiment of the invention and is detailed below.

[0027] The expression "first flow connection" generally refers to the intake of an adsorption column, however, because there are multiple directional flow capabilities of the adsorption units in the present invention in a preferred embodiment, a more generic expression is used to denote this structure. Similarly, for the expression "second flow connection," is substituted for and would normally would refer to the outflow on an adsorption column.

DETAILED DESCRIPTION OF THE DRAWINGS

[0028] FIGS. **1-4** were discussed above with reference to the prior art. **FIG. 5** depicts a sample cabinet unit **10** for housing the present invention in a preferred embodiment. Referring now to **FIG. 6, a** detail of one of the embodiments of the present invention in an inactive state is shown. The air purification system **100** is comprised of air purification tubing **101**, an inlet **102** and an outlet **104**, and an optional compressor **104** and water trap **110**. Also included are at least three types of adsorption column units **150**(upstream-u), **150**(downstream-d) and **150**(regen/s-r) A, **150(1)**, B **150(2)** and C **150(3)**, which will be described in detail below, but include a molecular sieve for removing impurities from air. For **FIG. 6**, column A **150(1)** will adsorb upstream (**150***u*), column B **150(2)** will adsorb downstream (**150***d*) and column C **150(3)** will be either in standby mode or regenerating (**150***s*) or (**150***r*). However, there are alternate embodiments where any of the columns can adsorb either upstream, downstream, or regenerate, which will be described in detail below.

[0029] Also included in air purification system **100** is an oxygen catalyst unit **200**, which will be described in detail below. The oxygen catalyst unit **200** is generally kept at approximately 300 degrees centigrade in a preferred embodiment, as that is a preferred temperature for changing CO and hydrocarbons into water and carbon dioxide. The air flow is controlled by a series of valves **115(***n***)**, which in a preferred embodiment are 4-way diverter valves and are connected to the tubing **101** throughout the system **100**. The invention also includes a regeneration air supply intake **180** and a regeneration air vent **182**. As can be appreciated by those skilled in the art, other types of valves would be appropriate in relation to the particular installation of the purification system **100**.

[0030] Referring now to **FIG. 7, a** preferred embodiment of the air purification system **100** in an "active" state is shown. Air is let in through an intake **102** and passed through an optional compressor **106** and then a water trap **110**. The water trap **110** will take air that is inlet at standard humidity, i.e. 10-100% relative humidity, and product outlet air that is generally less than 5000 ppm water vapor and is considered "semi-dry" air for the purposes of the present invention.

[0031] The "semi-dry" air, at approximately less than 5000 ppm water vapor, passes out of water trap **110**. The dry air then enters a first four way diverter valve **115(1)**, which directs the flow of the "semi-dried" air to the first upstream adsorption column **150***u*, which can be either adsorption column A **150(1)**, B **150(2)** or C **150(3)**, but for purposes of **FIG. 7** is shown as the A adsorption column **150(1)**. Air passing upstream through adsorption unit A **150(1)** will have remaining moisture and carbon dioxide and other impurities removed. The air then passes out of adsorption unit A **150(1)** through **4**-way diverter valve **115(4)** where it is directed to the oxygen catalyst unit **200**. Drying the air before passing it through a first purification unit **150(1)** has the effect of extending the life of the purification unit.

[**0032**] The semi clean dry air is flowed through the oxygen catalyst **200**, which converts hydrocarbons and carbon monoxide to carbon dioxide and water. The air then passes out of the oxygen catalyst unit **200**, and passes to 4-way diverted valve **115(2)** where it is directed to adsorption unit B **150(2) 150(*d*)** where it passes downstream and is purified for the new carbon dioxide and water as well as NOX creating purified air. The clean air passes through 4-way diverter valve **115(5)** where it is directed to the regeneration supply valve **180**, however most of the air passes through outlet flow **104**. The third adsorption column **150(3) 150**(s/r) is inactive and receives no air flow.

[**0033**] Referring now to **FIG. 8 a** preferred embodiment of the invention is shown in which the adsorption column units A **150(1) 150(*r*)**, B **150(2) 150(*d*)** and C **150(3) 150(*u*)** each include a heating means **250(1)**, **250(2)**, and **250(3)**, respectively, and a cooling means **350(1)**, **350(2)**, and **350(3)**, respectively. Such heating and cooling means may be provided in the way of a thermal blanket of or gradient type heating or heat exchanging systems such as gas to gas air exchanger or gas to air heat exchanger. Such structures are well known by those skilled in the art and would reflect the environmental demands of the present invention as it was installed in a particular site and do not need to be detailed here. In addition, **FIG. 8** includes and optional control unit **500**, and valve operation unit **520**, which may be comprised of solenoid valves in a preferred embodiment. Such control structures are generally well known by those skilled in the art and a variety of electrical, mechanical and pneumatic control types would be appropriate based on the installation requirement of the system.

[**0034**] The operation of system **100** is similar to that depicted in **FIG. 7**. However, now semi-dried air passes from the water trap **110** to 4-way diverted valve **115(3)**, where is enters adsorption column C **150(3)/150(*u*)** for upstream purification. The air enters the column where it is cooled by cooling means **350(3)** which are described above and is well known by the those skilled in the air help facilitate gas purification in the adsorption column **150(3)**. Heating means **250(3)** remains either inactive during upstream purification in a preferred embodiment or heats the semi-purified gas as it exits in an alternate embodiment so that it can be more easily heated for the oxygen catalyst unit **200**.

[**0035**] The semi-purified air then enters 4-way diverter valve **115(6)** where it is flowed to the oxygen catalyst unit **200**, the operation of which is detailed above. The oxygenated semi-purified air leave the oxygen catalyst unit **200** and flows to 4-way diverted valve **115(2)** where it is directed to adsorption column B **150(2)/150(*d*)** for purifying in a downstream direction. The gas enters adsorption column B **150(2)** where is it is cooled by cooling means **350(2)** which facilitates purification of the remaining impurities. The air leaves the adsorption column **150(2)/150(*d*)** as purified air and is flowed to both the outlet **104** and the regeneration supply **180**.

[**0036**] Furthermore, in **FIG. 8** purified air flows from the regeneration supply **180** into 4-way diverter valve **115(4)**, where it passes through adsorption unit A **150(1)/150(*r*)** which has active heating unit **250(1)** activated. The impurities stored in adsorption unit A **150(1)** may be released into the purified air and exits through **4**-way diverter valve **115(1)** and exits through the regeneration vent **182**. The heating unit **250(1)** also facilitates thermal regeneration of the adsorption column **150(1)** independent of the purified air. In a preferred embodiment the pressure is adjusted in the regenerating column **150(1)**, in order to facilitate regeneration. The processes of thermal regeneration of adsorption columns are known to those skilled in the art and do not need to be detailed here.

[**0037**] Referring now to **FIG. 9, a** scheduling schematic detailing the purification, standby, and regeneration cycles through **7** sample time periods, of the present invention in a preferred operation is shown. The operation of the present invention requires that one column always be purifying in the upstream mode (removing water, carbon dioxide, and other impurities) and one column is always purifying in a downstream manner removing water, carbon dioxide and NOX. In a preferred embodiment, one adsorption column is always either being regenerated or in a standby mode preparing to purify. A column may go to standby mode after regenerating before becoming active and replacing another purifying unit.

[**0038**] In the table depicted in **FIG. 9**, at time **1**, adsorption column A **150(1)** is purifying in the upstream mode, adsorption column B **150(2)** is purifying in downstream mode and adsorption column C **150(3)** is in a standby mode. This state is depicted by the invention as represented by **FIG. 7**. At time period **2**, column C **140**, starts purifying air in an upstream manner and column A **150(1)** starts regenerating, while column B **150(2)** continues purifying in a downstream manner. At time **3**, column A **150(1)** goes to standby mode, column B **150(2)** continues downstream purifying and column C **150(3)** continues upstream purifying. At time **4**, column B **150(2)** starts the regeneration process, while Column A **150(1)** starts purifying in a downstream mode. The cycle continues until all of the adsorption columns have been regenerated.

[**0039**] As can be appreciated by one skilled in the art, the time periods are representative of control cycles and do not represent any particular time period. The time periods to be equal to each and the control cycles of the present invention are shown for sample purposes only and will depend on the environment of the invention.

[**0040**] Referring now to **FIG. 10 a** regenerable adsorption column **150(*n*)**, as would be implemented in a preferred embodiment of the present invention is shown. The adsorption column **150(*n*)** includes an outer shell **151** and an insulator **155**. In a preferred embodiment, the outer shell is made of 304 SST. The column also includes an intake of first flow connection **152** and a large particle screen **154**, which has approximately a 0.05 inch opening in a preferred embodiment. Also included is a mole sieve chamber **160**, where a mole sieve **161** is housed. In a preferred embodiment, the molecular sieve **161** is one manufactured by Baylith, the specification of which are available from the manufacturer and are incorporated by reference. Another sample molecular sieve **161** used in an alternate embodiment of the present invention is UOP type WE-G 592, of which the technical materials are incorporated by reference.

[**0041**] Also included in the adsorption column **150(*n*)** are a primary adsorption chamber **180** which holds an adsorber

181. The adsorber **181** includes 5256 nickel catalyst by Englehard in a preferred embodiment, but may also include other adsorbers as will be appreciated by those skilled in the art. The technical specifications of the 5256 nickel catalyst are herein incorporated by reference. Also included in the regenerable adsorption column **150**(*n*) are a second output screen **190**, which is a 10 micrometer stainless steel filter by Mott in preferred embodiment, the details of which are available from the manufactured and are hereby incorporated by reference, and an outflow or second flow connection **192**.

[**0042**] Referring now to **FIG. 11**, an oxygen catalyst unit **200** as used in the present invention is shown. The oxygen catalyst unit **200** is usually kept at approximately 300 degrees centigrade for changing hydrocarbons and carbon monoxide in the air flow received from the upstream adsorption column **150**(*u*) into carbon dioxide and water vapor. The oxygen catalyst unit **200** comprises air intake **212** and outflow **214** units, heating means **210** covering the unit **200**. An intake screen **216** at the end of the air intake **212**, with an opening of approximately 0.05". The air exiting the oxygen catalyst at port **214** also passes through a filter of 10 micrometer (10μ) sintered metal **230**. The unit is covered by a shell **201**, which in a preferred embodiment is 304 stainless steel, but can be made of other materials and surrounds a secondary layer **224**, which surrounds the catalyst chamber **222**. The oxidation catalyst **220** sits in the chamber **222**.

[**0043**] The oxidation catalyst **220** is usually made of a palladium (Pd) or platinum (Pt) based catalyst and the technical specifications regarding a catalyst used in the preferred embodiment are incorporated herein by reference. One such catalyst is manufactured by Saes Getters of Milan, Italy, but as can appreciated by those skilled in the are may encompass several different types of catalysts.

[**0044**] The examples given in the specification are not meant to limit the scope of the invention, which as can be appreciated by those skilled in the art, can have many different implementations and component replacement without departing from the spirit of the invention. These may include, but are not limited to heating devices, cooling devices, valves, tubing, controllers, screens, molecular sieves, nickel catalysts, oxygen catalysts, compressors, water traps, etc. The scope of the invention is better defined by considering the following claims.

Having thus described our invention, we claim:

1. A process for the purification of air, whereby the ratio of nitrogen to oxygen is maintained, comprising the steps of:

flowing air through a first adsorption column in a first flow direction, whereby air is semi-purified;

flowing said semi-purified air through an oxygen catalyst, wherein said oxygen catalyst includes either a palladium catalyst or a platinum catalyst, whereby hydrocarbons carbon monoxide are converted to carbon dioxide and water;

flowing said oxygenated semi-purified air through a second adsorption column in a second flow direction; whereby said oxygenated semi-purified air has the remaining impurities removed, creating purified air.

2. The process as recited in claim 1, comprised of the additional step of removing a first portion of water from said air prior to said step of flowing air through a first adsorption column, by flowing air through a water trap, whereby semi-dried air results from said first portion of water removal step and said semi-dried air is less than 10,000 ppm of water vapor.

3. The process for purifying air as recited in claim 2, comprised of the additional step of compressing air before performing said first water removing step.

4. The process for purifying air as recited in claim 1, further comprised of flowing said purified air to both an outlet and to a third adsorption column, whereby said flow of air to said third adsorption column is a regenerative air supply.

5. The process for purifying air as recited in claim 4, further comprised of flowing said regenerative air supply out of said third adsorption column and out an escape vent.

6. The process for purifying air as recited in claim 4, further comprised of switching said first and said second flow directions wherein at least one of said adsorption columns has no air flowing through it or has a flow of said regenerative air supply flowing through it and at least another of said adsorption columns has oxygenated semi-purified air flowing through it in a second flow direction.

7. The process for purifying air as recited in claim 4, further comprised of heating said third adsorption column, whereby said heating facilitates thermal regeneration in said third adsorption column.

8. The process for purifying air as recited in claim 7, wherein said heating includes heating said regenerative air supply as it flows through said third adsorption column.

9. A process for the purification of air, whereby the ratio of nitrogen to oxygen is maintained in said air, comprising the steps of:

a step for removing a first portion of water from said captured air, wherein semi-dried air results from said removal step, whereby said semi-dried air is less than 10,000 ppm of water vapor;

flowing said semi-dried air through a first adsorption column in a first flow direction, whereby said dried air is semi-purified, wherein said flowing dried air through said first adsorption column includes the removal of moisture and carbon dioxide semi-purified air;

flowing said semi-purified air through an oxygen catalyst, wherein hydrocarbons carbon monoxide in said semi-purified air are converted in carbon dioxide and water, whereby oxygenated semi-purified air results;

flowing said oxygenated semi-purified air through a second adsorption column in a second flow direction; wherein said flowing through said second adsorption column includes removing remaining carbon dioxide, water and oxides of nitrogen from said oxygenated semi-purified air, whereby creating purified air with contaminants less than 10 parts per billion.

10. The process for purifying air as recited in claim 9, comprised of the additional step of flowing said purified air to both an outlet and to a third adsorption column, whereby said flowing purified air into said third adsorption column facilitates thermal regeneration.

11. The process for purifying aid as recited in claim 10, comprised of the additional step of flowing re-contaminated air out of said third adsorption column and out an escape vent.

12. The process for purifying air as recited in claim 10, comprised of the additional step of switching said flow directions in first adsorption column, said second adsorption column and said third adsorption columns, wherein, at any time, at least one of said adsorption columns has no air flowing through it or has a flow of purified air flowing through it and at least one adsorption column has oxygenated semi-purified air flowing through it and at least one adsorption column has semi-dried air flowing through it.

13. The process for purifying air as recited in claim 9, wherein said step for removing water is performed by a water trap.

14. The process for purifying air as recited in claim 9, wherein said flowing through first adsorption column includes cooling said semi-dried air, whereby the purification process in said first adsorption column is facilitated by said cooling.

15. The process for purifying air as recited in claim 9, wherein said flowing through second adsorption column includes cooling said oxygenated semi-dried air, whereby the purification process in said second adsorption column is facilitated by said cooling.

16. The process for purifying air as recited in claim 9, wherein said flowing through an oxygen catalyst is performed with heating.

17. The process for purifying air as recited in claim 16, wherein said heating is performed with the temperature between 200 and 400 degrees centigrade.

18. A process for purifying air including the steps of:

during time interval T, flowing unpurified air through a first adsorption column, in a first flow direction, resulting in a stream of semi-purified air; flowing said semi-purified air through a oxygen catalyst, resulting in oxygenated semi-purified air, and flowing said oxygenated semi-purified air through a second adsorption column in a second flow direction, wherein a third adsorption column has purified air flowing through it;

during time interval, T+1 time unit, said third adsorption column has said unpurified air flowing through it in a first flow direction, and said first adsorption column receives purified air from a source which is connected to said second adsorption column; and

during time interval, T+2 time units, said first adsorption column has said oxygenated semi-purified air flowing through it in a second flow direction, and said second adsorption column has purified air flowing through it.

19. The process for purifying air as recited in claim 18, further comprising the act of:

during time interval, T+3 time units, flowing unpurified air through a first adsorption column in a first flow direction resulting in a stream of semi-purified air; flowing said semi-purified air through a oxygen catalyst, resulting in oxygenated semi-purified air, and flowing said oxygenated semi-purified air through a second adsorption column in a second flow direction, wherein a third adsorption column has purified air flowing through it.

20. The process for purifying air as recited in claim 19, wherein in between time intervals T+2 time units and T+3 time units, said second adsorption column enters a standby mode where it does not receive a flow of air.

21. The process for purifying air as recited in claim 18, wherein in between time intervals T+1 time unit and T+2 time units, said first adsorption column enters a standby mode where it does not receive a flow of air.

22. The process for purifying air as recited in claim 18, further comprised of the step of at time T, heating said third adsorption column in order to facilitate thermal regeneration.

23. The process for purifying air as recited in claim 18, wherein said heating said third adsorption column includes heating said purified air.

24. The process for purifying air as recited in claim 18, wherein said time interval T is less than said time unit.

25. An air purification system, comprising:

an air intake and an air outflow and tubing; a compressor connected to said air intake; a water trap connected to said compressor, said water trap for removing water from air;

a set of more than one adsorption columns; and

an oxygen catalyst unit;

wherein said air is passed through said tubing from said water trap through a first of said set of adsorption columns, then passed through said oxygen catalyst unit, and then passed through a second of said set of adsorption columns, and optionally, said air outflow.

26. The air purification system as recited in claim 25, wherein flowing said air through said first of said set of adsorption columns at least removes water and carbon dioxide, wherein passing said air through said oxygen catalyst unit changes hydrocarbons and carbon monoxide into carbon dioxide and water, and passing said air through said second of said set of adsorption columns removes at least carbon dioxide, water and oxides of nitrogen.

27. The air purification system as recited in claim 25, further comprising a compressor, said compressor being for compressing said intake air.

28. The air purification system as recited in claim 25, wherein at least of said set of adsorption columns includes a heating unit.

29. The air purification system as recited in claim 28 wherein said heating unit has a heating gradient.

30. The air purification system as recited in claim 25, wherein at least one of said set of adsorption columns includes a cooling unit.

31. The air purification system as recited in claim 30, wherein said cooling unit is a gas to gas or a gas to air heat exchanger.

32. The air purification system as recited in claim 25, wherein at least one of said set of adsorption columns includes an outer shell, a molecular sieve, a nickel catalyst and a set of filters at both ends of said adsorption column connected to a first flow connection and a second flow connection, respectively.

33. The air purification system as recited in claim 32, wherein said at least one adsorption column includes a cooling unit at a first end, said first end in proximity to said first flow connection.

34. The air purification system as recited in claim 32, wherein said at least one adsorption column includes a heating unit at a second end, said heating unit in proximity to said second flow connection.

35. The air purification system as recited in claim 25, wherein said oxygen catalyst unit includes a large particle screen connected to a unit air intake, a oxidizing catalyst, and a sinter metal filter connected to an unit air outflow, and a heating means.

36. The air purification system as recited in claim 25, further comprised of a set of valves, said valves being for controlling said airflow.

37. The air purification system as recited in claim 36 wherein said set of valves includes four-way diverter valves.

38. The air purification system as recited in claim 36, further comprising a valve control unit, said valve control unit being for opening and closing said set of valves.

39. The air purification system as recited in claim 38, wherein said valve control unit further comprises control means for directing the flow of air through said first adsorption column in a first flow direction, wherein said control means further comprises means for directing said flow of air through said second adsorption column in a second flow direction, wherein said control means further comprises means for directing a regenerative flow of air from the outflow of said second adsorption column, wherein said regenerative flow of air is flowed through a third adsorption column.

40. The system as recited in claim 25, further including a regeneration air supply.

41. The air purification system as recited in claim 25, further comprised of tubing for flowing said purified air from the output of said second of said set of adsorption columns to a third of said set of adsorption columns, whereby said flow of purified air is a regenerative air supply.

42. The air purification system as recited in claim 41, wherein the system additionally comprises a regeneration vent, wherein said regenerative air supply flows through third of said of set of adsorption column and exits out said regeneration vent.

43. The air purification system as recited in claim 42, further comprising a heating unit, wherein said heating unit facilitates thermal regeneration in said third adsorption unit.

44. The air purification system as recited in claim 25, wherein said set of adsorption columns includes at least three columns, wherein during any time said system is in operation; a third column of said set of adsorption columns is regenerating, wherein said regeneration is facilitated by flowing a regeneration supply of purified air through said third adsorption column, wherein said third adsorption column further includes a heating unit, wherein said heating facilitates thermal regeneration.

45. The system as recited in claim 25, further including a regeneration supply intake and regeneration vent, wherein all of said set of adsorption columns include a heating unit and can be thermally regenerated by heating.

46. The air purification system as recited in claim 25, wherein said set of adsorption columns includes at least three columns, wherein during the process of purification, said first column of said set of adsorption columns is purifying in a first flow direction, whereby said first flow direction purifying is for at least removing oxides of nitrogen from air.

47. The air purification system as recited in claim 25, wherein said set of adsorption columns includes at least three columns, wherein during the process of purification, said second column of said set of adsorption columns is purifying in a second flow direction, whereby said second flow direction is for at least removing water vapor, carbon dioxides and oxides of nitrogen from air.

48. The system as recited in claim 25, wherein said oxygen catalyst unit is maintained at approximately 300 degrees centigrade.

49. The system as recited in claim 25, wherein said oxygen catalyst unit includes an catalyst comprising palladium.

50. The system as recited in claim 25, wherein said oxygen catalyst unit includes an catalyst comprising platinum.

51. The system as recited in claim 25, wherein one of said set of adsorption columns includes a Nickel catalyst.

52. The system as recited in claim 51, wherein said nickel catalyst is #5256 Nickel Catalyst.

53. The system as recited in claim 25, wherein one of said set of adsorption columns includes a molecular sieve.

54. The system as recited in claim 53, wherein said molecular sieve is manufactured by BAYLITH®.

55. The system as recited in claim 53, wherein said molecular sieve is UOP® WE-G 592.

56. An air purification system, comprising:

an air intake and air outflow and tubing; a compressor connected to said air intake; a water trap connected to said compressor, said water trap being for removing water from said air;

a set of more than one adsorption columns, wherein said air is passed through said tubing from said water trap before being passed though a first of said set of adsorption columns, whereby the life of said first adsorption column is extended.

57. The apparatus as recited in claim 56, wherein said adsorption unit comprises: a first flow connection; a large particle screen connected to said first flow connection, a molecular sieve, a nickel catalyst, a sintered metal filter which is connected to a second flow connection.

58. The apparatus as recited in claim 57, wherein the molecular sieve includes UOP type WE-G 592 or said molecular sieve is manufactured by BAYLITH.

59. The apparatus as recited in claim 56, further comprised of an oxygen catalyst unit, said oxygen catalyst unit including a catalyst including on of the following group: platinum or palladium.

60. An air purification system comprising:

tubing; said tubing for directing a flow of air;

a set of more than one adsorption columns;

a unit including an oxygen catalyst;

wherein said air flows through said tubing to a first of said set of adsorption columns and flows from said first adsorption column to said oxygen catalyst unit, and flows from said oxygen catalyst unit to a second of said set of adsorption columns.

61. The air purification system as recited in claim 60, wherein said set of one or more adsorption columns includes heating means.

62. The air purification system as recited in claim 60, wherein said set of one or more adsorption columns includes cooling means.

63. An air purification system as recited in claim 60, wherein said set of adsorption columns includes at least three columns, wherein during the process of purification, a third column of said set of adsorption columns is thermally regenerating.

64. The air purification system as recited in claim 63, wherein during the process of purification, said first column of said set of adsorption columns is purifying in a upstream, whereby said upstream purifying being for removing impurities from air.

65. The air purification system as recited in claim 64, wherein during the process of purification, said second column of said set of adsorption columns is purifying downstream, whereby said downstream purifying being for removing impurities from air.

66. The system as recited in claim 65, further including a regeneration air supply, said regeneration air supply for providing purified air, such that said purified air is supplied to said thermally regenerating third adsorption column.

67. The method for purifying air as recited in claim 9, further comprised of the step of compressing captured air prior to said water-removing step.

68. A method for extending the life of an adsorption column containing a molecular sieve and a sintered nickel catalyst, comprised of drying compressed air with a water trap and then flowing said dried compressed air through said adsorption column.

69. A method for extending the life of an oxygen catalyst unit, said oxygen catalyst unit including a catalyst comprising either palladium or platinum, and used in the process of purifying air, including the steps of removing water from air with a water trap creating dried air and then removing impurities form said dried air by use of a unit including a molecular sieve and a nickel catalyst before flowing air through said oxygen catalyst unit.

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