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(54) **METHOD AND APPARATUS FOR ADJUSTING OPERATING PARAMETERS OF A VACUUM PUMP ARRANGEMENT**

VERFAHREN UND VORRICHTUNG ZUM EINSTELLEN DER BETRIEBSGRÖSSEN EINER VAKUUMPUMPENANORDNUNG

PROCÉDÉ ET APPAREIL D'AJUSTEMENT DE PARAMÈTRES DE FONCTIONNEMENT D'UN SYSTÈME DE POMPE À VIDE

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EP 2 850 322 B1

Description

BACKGROUND OF THE INVENTION

[0001] This invention relates to a method and/or apparatus for adjusting the operating parameters of a vacuum pump arrangement, and more particularly to a method and/or apparatus for self-adjusting the power or temperature limits of the vacuum pump arrangement based on the thermal characteristics of the gas flowing through the vacuum pump arrangement.

[0002] A system used in semiconductor or other industrial manufacturing processes typically includes, among other things, a process tool, a vacuum pump arrangement having a booster pump and a backing pump, and an abatement device. In semiconductor manufacturing applications, the process tool typically includes a process chamber, in which a semiconductor wafer is processed into a predetermined structure. The vacuum pump arrangement is connected to the process tool for evacuating the process chamber to create a vacuum environment in the process chamber in order for various semiconductor processing techniques to take place. The gas evacuated from the process chamber by the vacuum pump arrangement might be directed to the abatement device, which destroys or decomposes harmful or toxic components of the gas before it is released to the environment.

[0003] Many semiconductor processing techniques are associated with injecting various gases into the process chamber at different steps. Hydrogen is one of the commonly used gases in processes, such as Metalorganic Chemical Vapor Deposition (MOCVD), Plasma Enhanced Chemical Vapor Deposition (PECVD), and silicon epitaxy. The gases that are rich in hydrogen often exhibit very different characteristics from those including heavier gaseous components. The gas with a large proportion of hydrogen tends to have a high thermal conductivity, whereas the gas with a large proportion of heavy gaseous components tends to have a lower thermal conductivity. When the hydrogen rich gas is pumped through a vacuum pump, the temperature differential between the rotor and the stator tends to be smaller than that when the gas contains a large proportion of heavy gaseous components. As a result, there is a lower risk for a vacuum pump pumping the hydrogen rich gas to seize due to a clash between the rotor and the stator caused by thermal expansion, as opposed to a vacuum pump pumping heavy gases.

[0004] Despite the well controlled risk of pump seizure, vacuum pumps used in semiconductor manufacturing processes are often not driven as hard as they can be. Besides hydrogen, other heavier gases are also present in various steps in many semiconductor manufacturing process cycles. In order to accommodate those heavier gases, the power limits of the vacuum pumps are often set conservatively in order to avoid pump seizure caused by a clash between the rotor and the stator. As a result, the vacuum pumps tend to be underutilized.

[0005] Moreover, setting temperature limits for vacuum pumps based on the thermal characteristics of the heavy gases tends to cause frequent nuisance tripping when the vacuum pumps are pumping hydrogen rich gases. The temperature of a vacuum pump is almost always monitored from the outside of the pump casing, whereas the critical temperatures inside the vacuum pump are inferred from the outside temperature. It is a common industry practice to set the limit conservatively based on the outside temperature of the vacuum pump in order to avoid the internal temperatures exceeding a predetermined safety level. Due to the high thermal conductivity of hydrogen, the temperature differential between the outside and the inside of the vacuum pump tends to be smaller when the vacuum pump is pumping the hydrogen rich gas as opposed to the heavy gases. Because the internal temperature of a vacuum pump tends to be higher than the temperature on the outside, a limit set based on the thermal characteristics of the heavy gases might be too conservative for hydrogen-rich pumped gases. When the vacuum pump is pumping the hydrogen rich gas, such limit can be easily exceeded, while there is little risk for the pump to seize. This leads to nuisance tripping or a false alarm being triggered.

[0006] Conventionally, it might be possible to adjust the rotational speed of the vacuum pumps in response to the state of the process chamber. An example can be found in US Patent No. 6,739,840, which is directed to a method for controlling the vacuum pumps based on a signal provided by an upstream process tool that indicates whether or not the process chamber is in operation for the purpose of reducing the power consumption of the vacuum pumps. However, such a method does not take into account the chemistry and other characteristics of the gases evacuated from the process chamber for the purpose of extracting maximum performance out of the vacuum pumps. Neither does it provide the capability of adjusting the power and/or temperature limits of the vacuum pumps based on the signal generated by the process tool.

[0007] Document FR2792083 discloses a vacuum pump arrangement comprising a booster pump and a backing pump with a rotation speed control based on speed profiles calculated from characteristics of the gases pumped.

[0008] As such, what is needed is a method and/or apparatus for adjusting the operating parameters of the vacuum pump based on the thermal characteristics of the gas currently flowing through the vacuum pump.

BRIEF SUMMARY OF THE INVENTION

[0009] The disclosure is directed to a method for adjusting operating parameters of a vacuum pump arrangement according to claim 1.

[0010] The disclosure is also directed to an apparatus according to claim 13.

[0011] The construction and method of operation of the invention, however, together with additional objectives and advantages thereof will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

FIG. 1 illustrates a schematic view of a system where a process chamber, a booster pump, and a backing pump are connected in series in accordance with some embodiments of the invention.

FIG. 2 illustrates a flow chart showing a method for self-adjusting the operating parameters of the booster pump and the backing pump in accordance with some embodiments of the invention.

FIG. 3 illustrates a graph comparing the power consumption curves of the vacuum pumps in various conditions in accordance with some embodiments of the invention.

DEATILED DESCRIPTION OF THE INVENTION

[0013] This disclosure is directed to a method and/or apparatus for adjusting the operating parameters of a vacuum pump arrangement in response to a signal indicative of the thermal characteristics of the gas being evacuated from a process tool upstream of the vacuum pump arrangement, or a determination of the thermal characteristics of the gas flowing through the vacuum pump arrangement based on power consumption patterns of the vacuum pump arrangement. The operating parameters of the vacuum pump arrangement can be adjusted in response to the signal received by the vacuum pump arrangement from a process tool that indicates the chemistry and thermal characteristics of the gas being evacuated from the process tool. Absent such signal, the thermal characteristics of the gases can be determined by analyzing the power consumption patterns, since different gases generate different power consumption patterns as they flow through the vacuum pump arrangement.

[0014] FIG. 1 illustrates a schematic view of a system 10 where a process chamber 12 and a vacuum pump arrangement 20 are connected in series in accordance with some embodiments of the invention. The vacuum pump arrangement 20 draws gases out of the process chamber 12 and creates a vacuum environment in it to carry out certain processes, such as depositions, etching, ion implantation, epitaxy, etc. The gases can be introduced into the process chamber 12 from one or more gas sources, such as the ones designated by 14a and 14b in this figure. The gas sources 14a and 14b can be connected to the process chamber 12 via control valves 16a and 16b, respectively. The timing of introducing various gases into the process chamber can be controlled by selectively turning on or off the control valves 16a and 16b. The flow rates of the gases introduced from the gas sources 14a and 14b into the process chamber 12 can be controlled by adjusting the fluid conductance of the control valves 16a and 16b. As discussed above, many semiconductor processing techniques, such as MOCVD, PECVD, and silicon epitaxy, often inject hydrogen rich gases into the process chamber 12 at one step, and other heavier gases at other steps. By "hydrogen rich," it is understood that the hydrogen component in the gas is 50% or more in mole fraction or 7% or more in mass fraction.

[0015] The vacuum pump arrangement 20 includes a booster pump 22 and a backing pump 24 connected in series. The inlet of the booster pump 22 is connected to the outlet of the process chamber 12. The outlet of the booster pump 22 is connected to the inlet of the backing pump 24. The outlet of the backing pump 24 might be connected to an abatement device (not shown in the figure) where the exhaust gases emitted from the backing pump 24 are treated in order to reduce the harmful impact the exhaust gases might have on the environment. Sensors (not shown in the figure) can be implemented in the vacuum pump arrangement 20 to collect data of various measurements, such as the temperatures, power consumptions, pump speeds, etc., of the booster pump 22 and the backing pump 24. Sensors can also be implemented to measure the gas pressures at the inlets and/or outlets of the booster pump 22 and/or the backing pump 24. A controller 30 can be implemented to adjust the parameters of the vacuum pump arrangement 20 in response to a signal indicating the chemistry and thermal characteristics of the gas being evacuated from the process chamber 12.

[0016] The controller 30 can be implemented in the vacuum pump arrangement 20 in the form of a control circuit, which can analyze the data to obtain power consumption patterns of the vacuum pump arrangement 20, and set the operating parameters of the vacuum pump arrangement 20 according to the power consumption patterns.

[0017] FIG. 2 illustrates a flow chart 100 showing a method for self-adjusting the operating parameters of the vacuum pump arrangement 20 in accordance with some embodiments of the invention. FIG. 3 illustrates an exemplary graph comparing the power consumption curves of the booster pump 22 and the backing pump 24 in various conditions. Referring to FIGs. 2 and 3, initially at step 102, the booster pump 22 and backing pump 24 are set at the hydrogen operating parameters suitable for pumping gases that are rich in hydrogen. The hydrogen operating parameters compared to the heavy gas operating parameters can have higher power or temperature limits. As discussed above, the hydrogen rich gas has a high thermal conductivity, which leads to a low temperature differential between the inside and outside of a vacuum pump, and therefore permits the vacuum pump to be driven harder.

[0018] Step 104 determines whether the power consumption of the booster pump is greater than a first predetermined threshold. If the power consumption is below the first predetermined threshold, the process goes back to the beginning of step 104. If the power consumption is above the first predetermined threshold, the process proceeds to step 106. Step 106 determines whether the power consumption of the backing pump is below a second predetermined threshold. If the power consumption is above the second predetermined threshold, the process goes back to the beginning of step 104. If the power consumption is below the second predetermined threshold, the process proceeds to step 108 where the booster pump and the backing pump are set to the heavy gas operating parameters.

[0019] As shown in FIG. 3, the power consumption curve of the booster pump pumping hydrogen is designated by 202, whereas the power consumption curve of the booster pump pumping air is designated by 204. The power consumption curve of the backing pump pumping hydrogen is designated by 208, whereas the power consumption curve of the backing pump pumping air is designated by 206. Here, hydrogen and air are used as the proxies of the hydrogen rich gas and heavy gas, respectively, for the purposes of explaining the process illustrated in FIG. 2. The x-axis represents the gas pressure at the inlet of the vacuum pump arrangement that is constructed by the serially connected booster pump and backing pump. The y-axis represents the power consumptions of the booster pump and the backing pump. The first and second predetermined thresholds are represented by horizontal lines designated by 210 and 212, respectively. At pressure PI, if hydrogen is pumped through the booster pump and the backing pump, the power consumption of the booster pump will fall below the first predetermined threshold 210, and the hydrogen operating parameters will remain unchanged. However, if air is pumped through the booster pump and the backing pump, at pressure PI, the power consumption of the booster pump will be higher than the first predetermined threshold 210, while the power consumption of the backing pump will be below the second predetermined threshold 212. As such, the booster pump and the backing pump will be set to the heavy gas operating parameters.

[0020] After the booster pump and the backing pump are set to the heavy gas operating parameters at step 108, the process proceeds to step 110 where the power consumption of the booster pump is compared to a third predetermined threshold. If the power consumption of the booster pump is above the third predetermined threshold, the process goes back to the beginning of the step 110. If the power consumption of the booster pump is below the third predetermined threshold, the process proceeds to step 112 where the speed of the booster pump is compared to a predetermined speed threshold. If the speed of the booster pump is slower than the predetermined speed threshold, the process goes back to the beginning of step 110. If the speed of the booster pump exceeds the predetermined speed threshold, the process goes back to step 102 where the booster pump and the backing pump are reset to the hydrogen operating parameters.

[0021] As shown in FIG. 3, the third predetermined threshold is represented by a horizontal line designated by 214. There are two regions in the graph where the power consumptions of the booster pump are below the third predetermined threshold, namely region 220 where the pressure is below P2 and region 222 where the pressure is above P3. If the booster pump is in region 220, its speed would exceed the predetermined speed threshold, and therefore it would be safe to reset the booster pump and the backing pump back to the hydrogen operating parameters. However, if the booster pump is in region 222, its speed would be slower than the predetermined speed threshold, due to the high pressure at the inlets of the pumps. In such condition, it is not safe to reset the pumps to the hydrogen operating parameters, because they would drive the pumps too hard, therefore risking their exceeding the safety limits.

[0022] The disclosed method is capable of adjusting the parameters of the vacuum pump arrangement based on the data collected from the vacuum pump arrangement. If it is determined that the hydrogen rich gas is being pumped through the vacuum pump arrangement, the hydrogen operating parameters will be employed to drive the vacuum pump arrangement harder than when the heavy gas operating parameters are used. This enables the vacuum pump arrangement to operate at a greater capacity, without risking the vacuum pump arrangement exceeding its power or temperature limits.

[0023] In some semiconductor manufacturing processes, a vacuum pump arrangement is used to pump both the hydrogen rich gas and the heavy gas at various steps. Conventionally, if the vacuum pump arrangement is designed according to the hydrogen gas flow, the size of the vacuum pump arrangement would need to be large in order to avoid pump seizure when it pumps the heavy gases. Unlike the conventional designs, the disclosed method and apparatus enables the vacuum pump arrangement to adjust or self-adjust its power or temperature limits in response to the thermal characteristics of the gas flowing through the arrangement. Thus, it enables the vacuum pump arrangement to be made in a smaller size, without compromising on its pumping capacity when it pumps the hydrogen rich gas or risking seizure when it pumps the heavy gas.

[0024] In addition to using the relationship between the power consumption and the inlet gas pressure to determine the thermal characteristics of the gas flowing through a vacuum pump arrangement, other relationships can also be used to make the determination. For example, the relationship between the power consumption and the pump speed might be used to determine the thermal characteristics of the gas flowing through the vacuum pump arrangement. As another example, the relationship between the power consumption and temperature of the pumps might be used to determine the thermal characteristics of the gas flowing through the vacuum pump arrangement. It is understood that setting the operating parameters of the vacuum pump arrangement based on those relationships can be achieved by applying the process illustrated in FIG. 2, with certain modifications accounting for the different curve patterns in those relationships. It is asserted that those modifications are within the scope of the present disclosure.

[0025] Although the invention is illustrated and described herein as embodied in one or more specific examples, it is nevertheless not intended to be limited to the details shown, since various modifications and structural changes may be made therein without departing from the scope of the claims. Accordingly, it is appropriate that the appended claims be construed broadly and in a manner consistent with the scope of the invention, as set forth in the following claims.

Claims

1. A method of adjusting operating parameters of a vacuum pump arrangement comprising a booster pump and a backing pump serially connected to a process chamber in a manner that the booster pump is downstream of the process chamber and upstream of the backing pump, the method comprising:

determining characteristics of a first gas flowing through the vacuum pump arrangement by monitoring a property of the vacuum pump arrangement as the vacuum pump arrangement pumps the first gas therethrough, and determining the characteristics of the first gas based on the monitored property; and

setting operating parameters of the vacuum pump arrangement based on the determined characteristics of the first gas.

2. The method of claim 1, wherein the property is a power consumption pattern.

3. The method of claim 2 wherein the step of determining characteristics of the first gas comprises determining whether a power consumption of the booster pump at a given moment is above a first predetermined threshold.

4. The method of claims 2 or 3, wherein the step of determining characteristics of the first gas comprises determining whether a power consumption of the backing pump at the given moment is below a predetermined second threshold, if the power consumption of the booster pump at the given moment is above the first predetermined threshold.

5. The method of claim 4, wherein the step of determining characteristics of the first gas comprises designating the first gas as a heavy gas if the power consumption of the backing pump is below the second predetermined threshold and the power consumption of the booster pump is above the first predetermined threshold at the given moment.

6. The method of claims 4 or 5, wherein the operating parameters are set to be heavy gas operating parameters in accordance with characteristics of the heavy gas if the power consumption of the backing pump is below the second predetermined threshold and the power consumption of the booster pump is above the first predetermined threshold at the given moment.

7. The method of any of claims 4, 5 or 6, wherein the step of determining characteristics of the first gas comprises designating the first gas as a hydrogen rich gas if the power consumption of the backing pump is above the second predetermined threshold and the power consumption of the booster pump is above the first predetermined threshold at the given moment.

8. The method of any of claims 4 to 5, wherein the operating parameters are set to be hydrogen operating parameters in accordance with characteristics of the hydrogen rich gas if the power consumption of the backing pump is above the second predetermined threshold and the power consumption of the booster pump is above the first predetermined threshold at the given moment.

9. The method of claims 7 or 8, wherein the hydrogen operating parameters have a power limit for the vacuum pump arrangement higher than that of the heavy gas operating parameters, or wherein the hydrogen operating parameters have a temperature limit for the vacuum pump arrangement higher than that of the heavy gas operating parameters.

10. The method of claim 6, wherein the step of determining characteristics of the first gas comprises determining whether the power consumption of the booster pump is below a third predetermined threshold, and

determining whether the booster pump exceeds a predetermined speed threshold, if the power consumption of the booster pump is below the third predetermined threshold.

11. The method according to claim 10, wherein the operating parameters are set to be hydrogen operating parameters in accordance with characteristics of the hydrogen rich gas, if the booster pump exceeds the predetermined speed threshold and the power consumption of the booster pump is below the third predetermined threshold.

12. The method according to any of claims 3 to 11, wherein the power consumption pattern comprises a relationship between a power consumption of the vacuum pump arrangement and either,
an inlet pressure of the vacuum pump arrangement,
a pump speed of the vacuum pump arrangement, or
a temperature of the vacuum pump arrangement.

13. An apparatus comprising:

a process tool having a process chamber;
a vacuum pump arrangement for evacuating the process chamber, comprising a booster pump and a backing pump serially connected to a process chamber in a manner that the booster pump is downstream of the process chamber and upstream of the backing pump, and
a controller configured to set operating parameter of the vacuum pump arrangement in response to information representing characteristics of a first gas flowing through the vacuum pump arrangement, wherein said information being deduced by determining characteristics of a first gas flowing through the vacuum pump arrangement by monitoring a property of the vacuum pump arrangement, as the vacuum pump arrangement pumps the first gas therethrough, and determining the characteristics of the first gas based on the monitored property, and
to set operating parameters of the vacuum pump arrangement based on the determined characteristics of the first gas.

14. The apparatus of claim 13, wherein the controller is further configured to determine whether a power consumption of the backing pump at a given moment is below a predetermined second threshold, if the power consumption of the booster pump at the given moment is above a first predetermined threshold.

Patentansprüche

1. Verfahren zum Einstellen von Betriebsparametern einer Vakuumpumpenanordnung, die eine Boosterpumpe und einer Vorpumpe umfaßt, die in Reihe mit einer Prozeßkammer in einer Weise verbunden sind, dass die Boosterpumpe stromab der Prozeßkammer und stromauf der Vorpumpe angeordnet ist, wobei das Verfahren umfaßt:

Bestimmen von Charakteristika eines ersten Gases, das durch die Vakuumpumpenanordnung strömt, durch Überwachen einer Eigenschaft der Vakuumpumpenanordnung, während die Vakuumpumpenanordnung das erste Gas durch sie hindurchpumpt, und Bestimmen der Charakteristika des ersten Gases basierend auf der überwachten Eigenschaft, und
Einstellen von Betriebsparametern der Vakuumpumpenanordnung basierend auf den bestimmten Charakteristika des ersten Gases.

2. Verfahren nach Anspruch 1, wobei die Eigenschaft ein Leistungsverbrauchsmuster ist.

3. Verfahren nach Anspruch 2, wobei der Schritt der Bestimmung von Charakteristika des ersten Gases das Bestimmen umfaßt, ob ein Leistungsverbrauch der Boosterpumpe in einem gegebenen Augenblick oberhalb einer ersten vorgegebenen Schwelle liegt.

4. Verfahren nach Anspruch 2 oder 3, wobei der Schritt der Bestimmung von Charakteristika des ersten Gases das Bestimmen umfaßt, ob ein Leistungsverbrauch der Vorpumpe in dem gegebenen Augenblick unterhalb einer vorgegebenen zweiten Schwelle liegt, wenn der Leistungsverbrauch der Boosterpumpe in dem gegebenen Augenblick oberhalb der ersten vorgegebenen Schwelle liegt.

5. Verfahren nach Anspruch 4, wobei der Schritt des Bestimmens von Charakteristika des ersten Gase das Bezeichnen des ersten Gases als ein schweres Gas umfaßt, wenn der Leistungsverbrauch der Vorpumpe unterhalb der zweiten vorgegebenen Schwelle und der Leistungsverbrauch der Boosterpumpe oberhalb der ersten vorgegebenen Schwelle in dem gegebenen Augenblick liegt.

6. Verfahren nach Anspruch 4 oder 5, wobei die Betriebsparameter auf Schwergas-Betriebsparameter gemäß Charakteristika des schweren Gases eingestellt werden, wenn der Leistungsverbrauch der Vorpumpe unterhalb der zweiten vorgegebenen Schwelle und der Leistungsverbrauch der Boosterpumpe oberhalb der ersten vorgegebenen Schwelle in dem gegebenen Augenblick liegt.

7. Verfahren nach einem der Ansprüche 4, 5 oder 6, wobei der Schritt des Bestimmens von Charakteristika des ersten Gases das Bezeichnen des ersten Gases als ein wasserstoffreiches Gas umfaßt, wenn der Leistungsverbrauch der Vorpumpe oberhalb der zweiten vorgegebenen Schwelle und der Leistungsverbrauch der Boosterpumpe oberhalb der ersten vorgegebenen Schwelle in dem gegebenen Augenblick liegt.

8. Verfahren nach einem der Ansprüche 4 bis 5, wobei die Betriebsparameter auf Wasserstoff-Betriebsparameter gemäß Charakteristika des wasserstoffreichen Gases eingestellt werden, wenn der Leistungsverbrauch der Vorpumpe oberhalb der zweiten vorgegebenen Schwelle und der Leistungsverbrauch der Boosterpumpe oberhalb der ersten vorgegebenen Schwelle in dem gegebenen Augenblick liegt.

9. Verfahren nach Anspruch 7 oder 8, wobei die Wasserstoff-Betriebsparameter eine Leistungsgrenze für die Vakuumpumpenanordnung haben, die höher als diejenige der Schwergas-Betriebsparameter ist, oder wobei die Wasserstoff-Betriebsparameter eine Temperaturgrenze für die Vakuumpumpenanordnung haben, die höher als diejenige der Schwergas-Betriebsparameter ist.

10. Verfahren nach Anspruch 6, wobei der Schritt des Bestimmens von Charakteristika des ersten Gases das Bestimmen umfaßt, ob der Leistungsverbrauch der Boosterpumpe unterhalb einer dritten vorgegebenen Schwelle liegt,
und das Bestimmen umfaßt, ob die Boosterpumpe eine vorgegebene Drehzahlschwelle überschreitet, wenn der Leistungsverbrauch der Boosterpumpe unterhalb der dritten vorgegebenen Schwelle liegt.

11. Verfahren nach Anspruch 10, wobei die Betriebsparameter als Wasserstoff-Betriebsparameter gemäß Charakteristika des wasserstoffreichen Gases eingestellt werden, wenn die Boosterpumpe die vorgegebene Drehzahlschwelle übersteigt und der Leistungsverbrauch der Boosterpumpe unterhalb der dritten vorgegebenen Schwelle liegt.

12. Verfahren nach einem der Ansprüche 3 bis 11, wobei das Leistungsverbrauchsmuster ein Verhältnis zwischen einem Leistungsverbrauch der Vakuumpumpenanordnung und entweder
einem Einlaßdruck der Vakuumpumpenanordnung,
oder einer Pumpendrehzahl der Vakuumpumpenanordnung,
oder einer Temperatur der Vakuumpumpenanordnung umfaßt.

13. Einrichtung mit:

einem Prozeßwerkzeug mit einer Prozeßkammer;
einer Vakuumpumpenanordnung zum Evakuieren der Prozeßkammer, die einer Boosterpumpe und einer Vorpumpe umfaßt, die in Reihe mit der Prozeßkammer in einer Weise angeordnet sind, dass die Boosterpumpe stromab der Prozeßkammer und stromauf der Vorpumpe angeordnet ist, und
einem Regler, der dafür konfiguriert ist, Betriebsparameter der Vakuumpumpenanordnung in Abhängigkeit einer Information einzustellen, welche Charakteristika eines ersten Gases darstellt, das durch die Vakuumpumpenanordnung strömt, wobei diese Information abgeleitet wird durch Bestimmen von Charakteristika eines ersten Gases, das durch die Vakuumpumpenanordnung strömt, durch Überwachen einer Eigenschaft der Vakuumpumpenanordnung, während die Vakuumpumpenanordnung das erste Gas durch sie hindurchpumpt, und durch Bestimmen der Charakteristika des ersten Gases basierend auf der überwachten Eigenschaft, und
Betriebsparameter der Vakuumpumpenanordnung basierend auf den bestimmten Charakteristika des ersten Gases einzustellen.

14. Einrichtung nach Anspruch 13, wobei der Regler weiter dafür konfiguriert ist, zu bestimmen, ob ein Leistungsverbrauch der Vorpumpe in einem gegebenen Augenblick unterhalb einer vorgegebenen zweiten Schwelle liegt, wenn der Leistungsverbrauch der Boosterpumpe in dem gegebenen Augenblick oberhalb einer ersten vorgegebenen Schwelle liegt.

Revendications

1. Procédé d'ajustement de paramètres de fonctionnement d'un agencement de pompe à vide comprenant une pompe de suralimentation et une pompe auxiliaire connectées en série à une chambre de traitement de sorte que la pompe de suralimentation soit en aval de la chambre de traitement et en amont de la pompe auxiliaire, le procédé comprenant :

la détermination de caractéristiques d'un premier gaz s'écoulant à travers l'agencement de pompe à vide en surveillant une propriété de l'agencement de pompe à vide à mesure que l'agencement de pompe à vide pompe le premier gaz au travers, et la détermination des caractéristiques du premier gaz sur la base de la propriété surveillée ; et
le réglage de paramètres de fonctionnement de l'agencement de pompe à vide sur la base des caractéristiques déterminées du premier gaz.

2. Procédé selon la revendication 1, dans lequel la propriété est un schéma de consommation de puissance.

3. Procédé selon la revendication 2, dans lequel l'étape de détermination de caractéristiques du premier gaz comprend le fait de déterminer si la consommation de puissance de la pompe de suralimentation à un moment donné est au-dessus d'un premier seuil prédéterminé.

4. Procédé selon les revendications 2 ou 3, dans lequel l'étape de détermination de caractéristiques du premier gaz comprend le fait de déterminer si une consommation de puissance de la pompe auxiliaire au moment donné est en dessous d'un deuxième seuil prédéterminé, si la consommation de puissance de la pompe de suralimentation au moment donné est au-dessus du premier seuil prédéterminé.

5. Procédé selon la revendication 4, dans lequel l'étape de détermination de caractéristiques du premier gaz comprend la désignation du premier gaz en tant qu'un gaz lourd si la consommation de puissance de la pompe auxiliaire est en dessous du deuxième seuil prédéterminé et si la consommation de puissance de la pompe de suralimentation est au-dessus du premier seuil prédéterminé au moment donné.

6. Procédé selon les revendications 4 ou 5, dans lequel les paramètres de fonctionnement sont réglés pour être des paramètres de fonctionnement de gaz lourd en conformité avec des caractéristiques du gaz lourd si la consommation de puissance de la pompe auxiliaire est en dessous du deuxième seuil prédéterminé et si la consommation de puissance de la pompe de suralimentation est au-dessus du premier seuil prédéterminé au moment donné.

7. Procédé selon l'une quelconque des revendications 4, 5 ou 6, dans lequel l'étape de détermination de caractéristiques du premier gaz comprend la désignation du premier gaz en tant qu'un gaz riche en hydrogène si la consommation de puissance de la pompe auxiliaire est au-dessus du deuxième seuil prédéterminé et si la consommation de puissance de la pompe de suralimentation est au-dessus du premier seuil prédéterminé au moment donné.

8. Procédé selon l'une quelconque des revendications 4 et 5, dans lequel les paramètres de fonctionnement sont réglés pour être des paramètres de fonctionnement d'hydrogène en conformité avec des caractéristiques du gaz riche en hydrogène si la consommation de puissance de la pompe auxiliaire est au-dessus du deuxième seuil prédéterminé et si la consommation de puissance de la pompe de suralimentation est au-dessus du premier prédéterminé au moment donné.

9. Procédé selon la revendication 7 ou 8, dans lequel les paramètres de fonctionnement d'hydrogène ont une limite de puissance pour l'agencement de pompe à vide supérieure à celle des paramètres de fonctionnement de gaz lourd, et dans lequel les paramètres de fonctionnement d'hydrogène ont une limite de température pour l'agencement de pompe à vide supérieure à celle des paramètres de fonctionnement de gaz lourd.

10. Procédé selon la revendication 6, dans lequel l'étape de détermination de caractéristiques du premier gaz comprend le fait de déterminer si la consommation de puissance de la pompe de suralimentation est en dessous d'un troisième seuil prédéterminé, et
le fait de déterminer si la pompe de suralimentation dépasse un seuil de vitesse prédéterminé, si la consommation de puissance de la pompe de suralimentation est en dessous du troisième seuil prédéterminé.

11. Procédé selon la revendication 10, dans lequel les paramètres de fonctionnement sont réglés pour être des paramètres de fonctionnement d'hydrogène en conformité avec les caractéristiques du gaz riche en hydrogène, si la pompe de suralimentation dépasse le seuil de vitesse prédéterminé et si la consommation de puissance de la pompe de suralimentation est en dessous du troisième seuil prédéterminé.

12. Procédé selon l'une quelconque des revendications 3 à 11, dans lequel le schéma de consommation de puissance comprend une relation entre une consommation de puissance de l'agencement de pompe à vide et soit,
une pression d'entrée de l'agencement de pompe à vide,
une vitesse de pompe de l'agencement de pompe à vide, soit
une température de l'agencement de pompe à vide.

13. Appareil comprenant :

un outil de traitement ayant une chambre de traitement ;
un agencement de pompe à vide pour évacuer la chambre de traitement, comprenant une pompe de suralimentation et une pompe auxiliaire connectées en série à une chambre de traitement de sorte que la pompe de suralimentation soit en aval de la chambre de traitement et en amont de la pompe auxiliaire, et
un dispositif de commande configuré pour régler un paramètre de fonctionnement de l'agencement de pompe à vide en réponse à des informations représentant des caractéristiques d'un premier gaz s'écoulant à travers l'agencement de pompe à vide, dans lequel lesdites informations sont déduites en déterminant des caractéristiques d'un premier gaz s'écoulant à travers l'agencement de pompe à vide en surveillant une propriété de l'agencement de pompe à vide, à mesure que l'agencement de pompe à vide pompe le premier gaz au travers, et en déterminant les caractéristiques du premier gaz sur la base de la propriété surveillée, et
pour régler des paramètres de fonctionnement de l'agencement de pompe à vide sur la base des caractéristiques déterminées du premier

gaz.

14. Appareil selon la revendication 13, dans lequel le dispositif de commande est en outre configuré pour déterminer si une consommation de puissance de la pompe auxiliaire à un moment donné est en dessous d'un deuxième seuil prédéterminé, si la consommation de puissance de la pompe de suralimentation au moment donné est au-dessus d'un premier seuil prédéterminé.

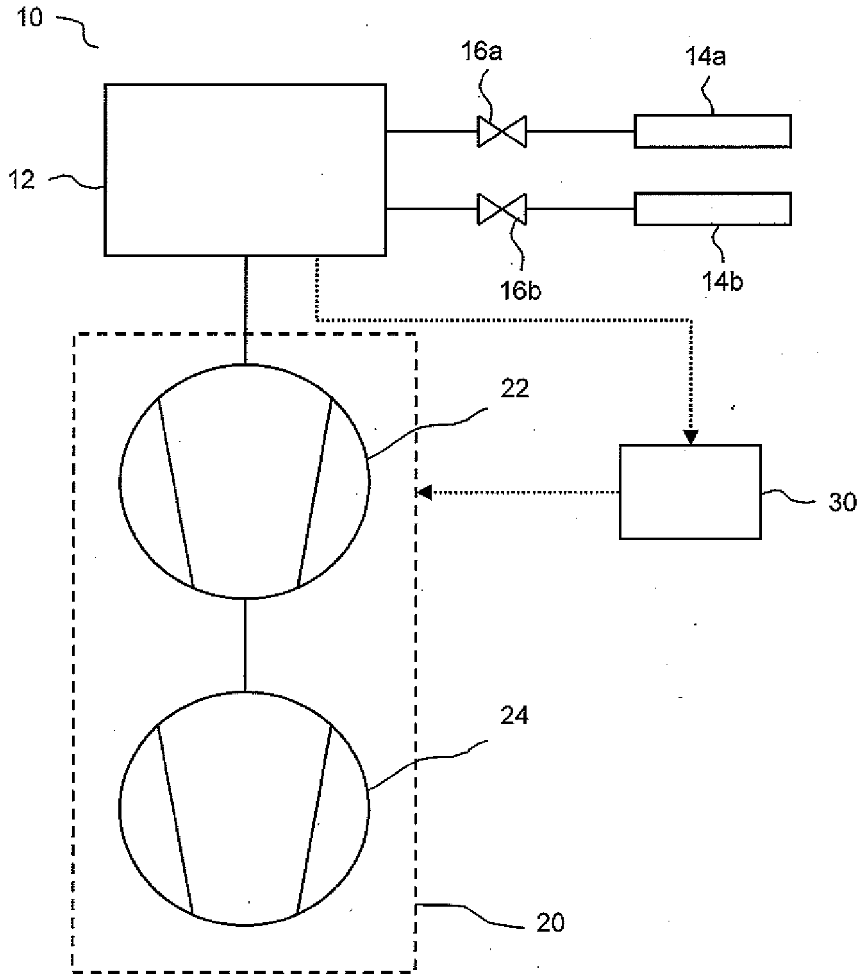

FIG. 1

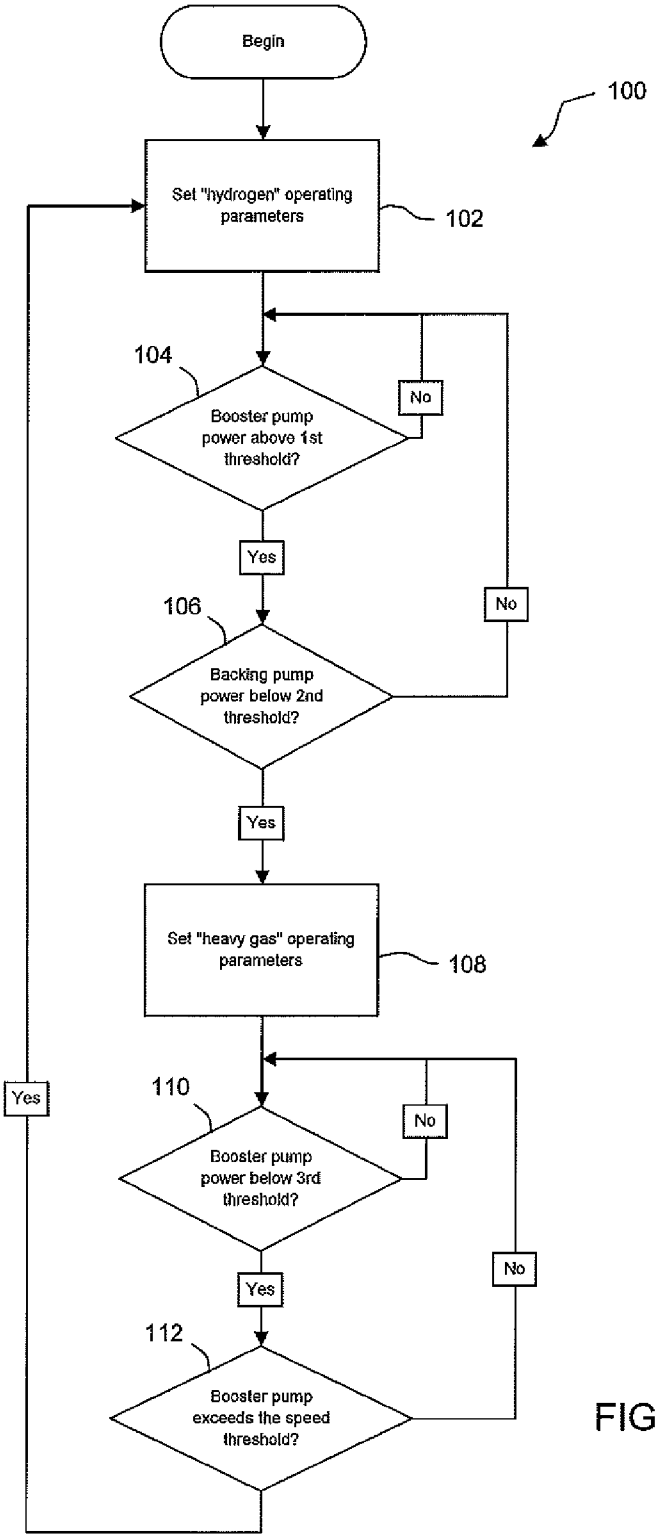
Begin
100
Set "hydrogen" operating parameters
102
104
Booster pump power above 1st threshold?
No
Yes
106
Backing pump power below 2nd threshold?
No
Yes
Set "heavy gas" operating parameters
108
110
Booster pump power below 3rd threshold?
No
Yes
112
Booster pump exceeds the speed threshold?
No
Yes

FIG. 2

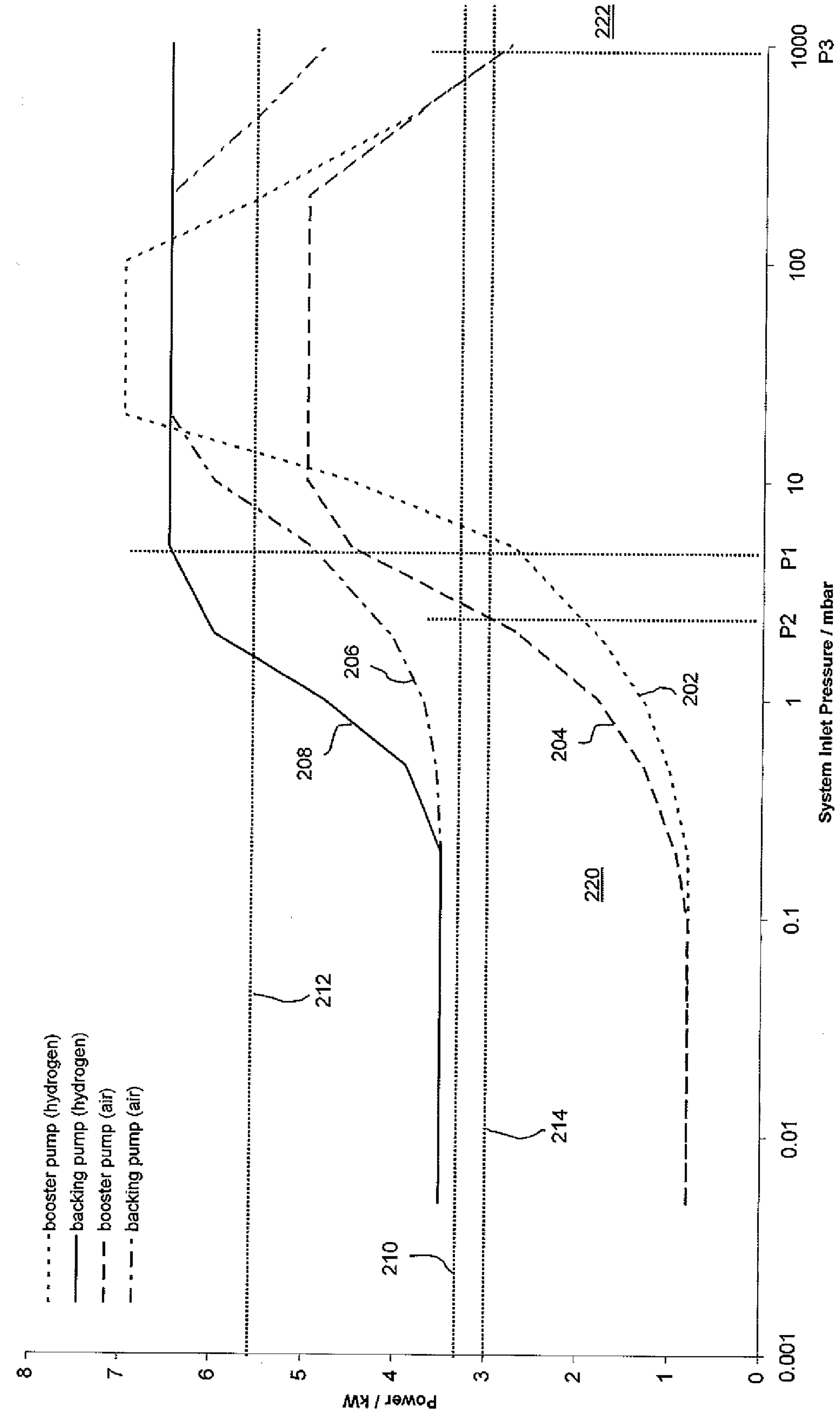
booster pump (hydrogen)
backing pump (hydrogen)
booster pump (air)
backing pump (air)
Power / kW
0
1
2
3
4
5
6
7
8
System Inlet Pressure / mbar
0.001
0.01
0.1
1
10
100
1000
P1
P2
P3
202
204
206
208
210
212
214
220
222

FIG. 3

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- US 6739840 B **[0006]**
- FR 2792083 **[0007]**