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3,221,197

SCAVENGING SYSTEM

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FIG. 1.

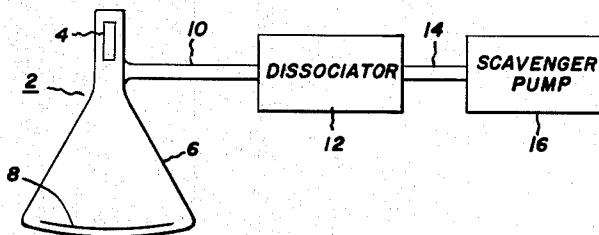


FIG. 2.

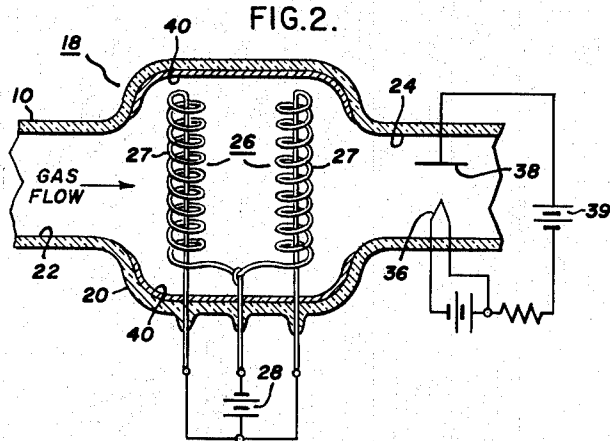


FIG. 3.

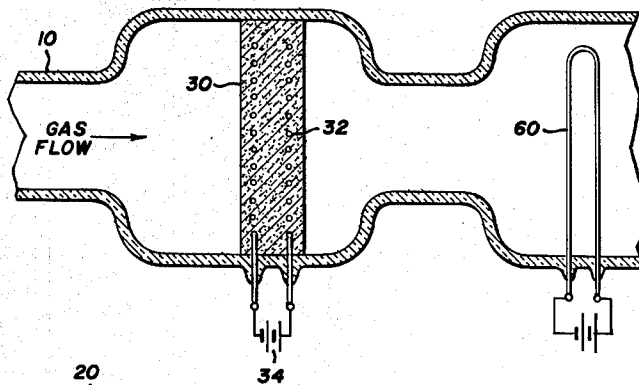
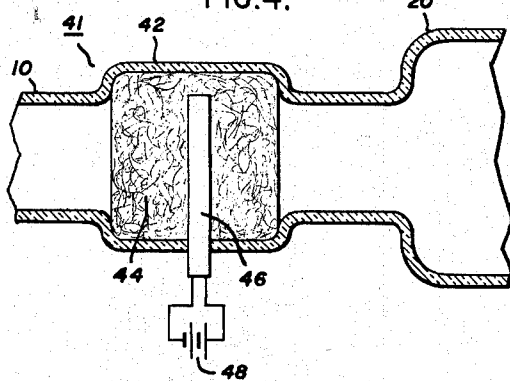


FIG. 4.



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SCAVENGING SYSTEM

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 26 Claims. (Cl. 313-7)

This invention relates to improvements in gas scavenging or gettering apparatus for high-vacuum apparatus such as electron discharge devices, and more particularly to scavenging or gettering apparatus for use with electron discharge devices containing organic materials, to scavenge undesired organic gases therefrom.

In the operation of high vacuum apparatus wherein organic gases are generated, for example as a result of electron irradiation or other phenomena, it has been found that certain known gas scavenging materials such as heated titanium or zirconium, as well as the flashable getter materials such as barium conventionally used in some types of electron discharge devices, soon lose their gas scavenging ability. This loss of gettering power appears to be due at least in part to a carburization phenomenon which gradually forms a coating of carbonaceous material over the gas scavenging surfaces of the getter materials, apparently isolating such surfaces from gas molecules to be scavenged.

Maintenance of a desirably high vacuum in the presence of release of organic gases in an electron discharge device is a problem even when the electron discharge device is arranged to be of the unsealed-envelope or continuously pumped type, and resort is had to an associated continuously operating scavenger pump of, for example, the ionic type. The scavenging ability of the pump is soon deleteriously affected by the organic gases and resulting carburization or formation of insulating tar-like materials on the various electrode surfaces of the pump, which deposits apparently upset the voltage relationships desired for effective pumping action.

As is known to those skilled in the art, the usual operation of such an ion pump involves the emission of electrons from a cathode, which may be heated or may operate as a cold emitter. The electrons caused to follow paths, which may be made tortuous by the interaction of magnetic fields, through a region containing gases to be scavenged. The resulting bombardment of the gas atoms or molecules by the electrons produces gas ions. The positive ions resulting are drawn to the cathode, which usually consists of a metal which may have a chemical affinity for certain of the ions and which also is readily sputterable by the ion bombardment. Some of the ions are buried in the cathode itself, and the resultant sputtering action buries other ions beneath a blanket of sputtered metal on other surfaces of the ion pump.

Even with such a continuously operating ion pump, the presence of organic gases apparently quickly blankets the active scavenging surfaces and thereby renders the pump ineffective, and the resultant deterioration in vacuum eventually destroys the emitter of the electron discharge device itself.

Accordingly, one object of the invention is to provide an improved gas scavenging system for substantially prolonging the operating life of electron discharge devices of the type having organic materials within the electron discharge environment thereof.

Another object is to provide improved apparatus for gettering or scavenging organic molecules in a partially or substantially evacuated system.

Another object is to provide such scavenging apparatus which enables an electron discharge device with which it is associated to have a permanently sealed envelope, within which, or in a sealed appendage to which, the scavenging apparatus may be situated.

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Another object is to provide such apparatus including a vacuum pump of the ionic type, and wherein special provision is made for preventing contamination and reduction of the pumping ability of the ion pump by materials which the ion pump itself cannot adequately dispose of.

Another object is to provide improved apparatus for generating hydrogen from a relatively inexpensive hydrocarbon source.

Another object is to provide a gas scavenging system of the character described wherein operation of the gas scavenging system generates as a by-product of such operation additional gettering or gas scavenging material.

Another object is to provide a gas scavenging system of the character described which is inexpensive, compact, and capable of operating for relatively long periods of the order of several thousands of hours.

Another object is to provide apparatus for scavenging organic gases which is particularly suitable for attachment to or association with an electron discharge device of the type wherein organic gases are generated during operation of the electron discharge device.

Another object is to provide such organic gas scavenging apparatus which is particularly suitable for attachment to or association with an electron discharge device of the electron beam type wherein an organic target is subjected to impingement by an electron beam and thereby gives off organic gases.

These and other objects of the invention will be apparent from the following description taken in conjunction with the accompanying drawings wherein:

FIGURE 1 is a schematic block diagram of a scavenging system constructed in accordance with the present invention;

FIGURE 2 is a fragmentary detailed sectional view of one form of a portion of the system of FIGURE 1;

FIGURE 3 is a fragmentary sectional view of another form of portions of the system of FIGURE 1; and

FIGURE 4 is a fragmentary sectional view of another portion of the system of FIGURE 1.

Briefly the present invention provides a scavenging system wherein organic materials to be scavenged are subjected to a preliminary dissociation by which they are converted or decomposed into lower molecular weight components as well as their carbon, hydrogen and other constituents. After such dissociation, the various constituents are exposed to a series of scavenging agents by means of which the particular constituents of the organic materials are selectively scavenged, the series of scavenging agents being arranged in such a way that succeeding scavenging agents are protected from exposure to contaminating or saturating, constituents, or from otherwise being rendered ineffectual, by the scavenging action of the preceding scavenging agents.

Turning to the drawing, FIGURE 1 shows an exemplary source 2 of organic material to be scavenged. The source 2 is shown as an electron discharge device of the electron beam type wherein the beam is generated by an electron gun 4 in an evacuable envelope 6 and impinges upon a target 8 within the envelope. The target 8 may be an organic material of a type such that under bombardment by the electron beam various organic gases are given off by the target, such as methane, ethane, and benzene, as well as high molecular weight hydrocarbons. Such an electron discharge device 2 may be intended to be operated under evacuated conditions wherein the desired ambient pressures are of the order of 10^{-5} to 10^{-7} millimeters of mercury, or less. As is well recognized by those skilled in the art, if allowed to remain unscavenged in such an environment, the organic gases generated by such electron bombardment would very quickly contaminate

the electron emitter as well as destroy the desired degree of evacuation of the discharge device.

According to my invention, electron discharge device 2 is connected by a gas flow passage 10 to a dissociator 12 which in turn is connected by a gas flow passage 14 to a scavenger pump 16, as will be more fully described hereinafter. Dissociator 12 consists of means for breaking down or decomposing the organic gases into various molecular, parti-molecular and atomic constituents. According to one form of my invention such dissociation may be accomplished pyrolytically, that is by application of heat.

Suitable pyrolytic dissociator means 18 is shown in greater detail in FIGURE 2 and includes a container 20 of any suitable material such as glass, refractory material, or suitable metal, having a gas inlet 22 and an outlet 24. Within the container 20 is a heated body 26 which may be made of any suitable material having an adequately long life at elevated temperatures of the order of 1000-1100 C. The heated body may be for example a filament 27 of refractory metal such as tungsten or rhenium resistance heated by means of a potential source 28 or the like. If chemical reaction between the heated body 26 and the gases to be scavenged is undesired, the heated body 26 may be coated or otherwise protected by a material such as aluminum oxide which is substantially non-reactive chemically with the organic gas input to the pyrolytic station. Alternatively, the heated body 26 may consist of a porous refractory member 30, as shown in FIGURE 3, of a material such as beryllium oxide or aluminum oxide, brought to a suitable operating temperature by a heater 32 and potential source 34.

Other types of organic molecule dissociation may be employed at dissociator 12 within the contemplation of the invention. For example in addition to or in lieu of the pyrolytic means 18, there may be used a suitable chemical catalyst, the presence of which produces or enhances the decomposition of one or more of the organic gases desired to be scavenged. Examples of suitable catalysts are activated alumina, activated silica, activated magnesium oxide, activated carbon, and activated aluminum silicate. Catalysts may also be used which comprise suitable noble metals such as platinum or palladium.

Dissociator 12 may also employ ionization to produce or enhance the dissociation of the organic materials desired to be scavenged. A suitable source of ions may be provided within or adjacent container 20, as best shown in FIGURE 2, for example by means of a directly heated electron emitter 36 and a spaced anode 38 connected to a suitable potential source 39. The electrons emitted from emitter 36 collide with the molecules of organic gases in the container 20, forming ions which in turn react with enhanced efficiency with the heated body 26 and dissociate into their various constituents, including carbon and hydrogen. Alternatively, ionization alone may be employed as a dissociation mechanism, in the absence of any direct pyrolytic dissociation, where provision of heated dissociating elements is undesired. However, in this event protection of the ionization source against contamination by organics, or selection of an ion source not deleteriously affected by the presence of the organics, may be required.

The free carbon thus derived by the decomposition of organic materials in dissociator 12 deposits as shown at 40 on the available adjacent surfaces such as the walls of the container 20. A unique feature of the present invention is that the resulting layer of carbon 40 which is thus gradually built up on the walls of container 20 or other available surfaces of dissociator 12, further enhances the efficiency of gas scavenging action by the dissociator because the carbon layer 40 itself serves as a scavenging material for some of the other dissociated products which may be present, such as fragments of hydrocarbon or other organic molecules, carbon monoxide, carbon diox-

ide, and the like. Moreover, since this carbon layer 40 is continually being built up by the dissociating process, its surface is continually being renewed as a sorber for gases to be scavenged.

Desirably the pyrolytic dissociating means 18 may be so constructed and arranged as to provide therein or adjacent thereto surfaces or areas of reduced temperature. Such surfaces of reduced temperature are useful for preferentially receiving depositions of carbon and their relative coolness inhibits desorption of gases which are scavenged by the deposited carbon. These cool surfaces may be provided by any suitable artificial cooling means if desired, or conveniently by being situated as remotely as possible, consistent with deposition of carbon thereon, from the heated elements of the pyrolytic station.

Oxygen bearing compounds of elements such as barium, calcium and strontium having, when reduced, a gas scavenging ability may also be utilized within the pyrolytic station to oxidize various dissociation products of the organic gases, thereby forming, for example, carbon monoxide or carbon dioxide from available carbon. Also after reduction of such compounds, the resulting metals such as barium can scavenge other dissociation products of the organic gases.

Optionally, the dissociator 12 may include, in advance of any pyrolytic, ionization or catalytic dissociating means as heretofore described, a molecular filtration means 41 as best shown in FIGURE 4. The filtration means 41 includes a container 42 in which is situated a charge of organic gas sorbing material 44 such as one or more of the zeolites, activated alumina, activated charcoal or the like. If desired, the composition of the molecular sorbing materials may be particularly suited to particular gas constituents to be scavenged. For example if benzene is to be scavenged then an absorption material of the zeolites family, such as Molecular Sieve Material Type 13X, available from the Linde Air Products Co., or activated charcoal may effectively be employed. Likewise if methane is a particular constituent of the gases to be scavenged the filtration means 41 may contain suitable commercially available zeolites such as Linde Air Products Co. Molecular Sieve Material Types 4A and 5A.

The efficiency of absorption of the molecular filtration means 41 is somewhat dependent upon the ambient temperature of the charge of absorbent material 44 therein, and accordingly it is contemplated in the present invention that cooling means may be provided for maintaining the charge of sorbing material 44 at or below room temperature. For this purpose any suitable cooling means may be employed, such as one or more Peltier junctions, shown schematically at 46 in FIGURE 4, and suitably energized from a potential source 48.

Gases remaining after treatment by the dissociator 12 are those which have neither been extracted by the molecular filtration means 41 nor scavenged by other portions of dissociator 12, and such residual gases can be expected to consist essentially of hydrogen with perhaps some carbon monoxide, carbon dioxide, water, nitrogen, and perhaps traces of oxygen. Through passage 14 these residual constituents are exposed to the final stage of the gettering system, which is the scavenging pump 16 as shown in FIGURE 1. Scavenging pump 16 may preferably be an ion pump of conventional design, either of the thermal evaporation or cold cathode type, or pump 16 may if desired be a diffusion pump or other suitable residual gas scavenging pump. Particularly when hydrogen is the principal residual gas, pump 16 may consist for example of a suitably heated member of a material, such as titanium, having good hydrogen absorption capability, such as shown at 60 in FIGURE 3.

It is further contemplated according to the present invention that the molecular filter 41 and the other portions of dissociator 12 may conveniently be packaged as an appendage to, or integral portion of the inlet of the scavenging pump 16.

It is also contemplated that if reduced levels of efficiency of the system can be tolerated, or in such situations as for example where cost is an important factor, or where the constituents of the organic gases to be scavenged are such that the pyrolytic dissociation means **18** alone provides sufficiently effective scavenging in advance of an ion pump or equivalent scavenging pump **16**, then under such circumstances the molecular filter **41** can be eliminated.

It should further be appreciated that apparatus constructed according to my invention has utility beyond that of gettering or gas scavenging apparatus. For example, with the hydrogen scavenging stage removed or rendered inoperative, it provides an effective means of removing all constituents except hydrogen from a suitable low cost organic source, and thus can serve as an effective generator of hydrogen gas.

It will be appreciated by those skilled in the art that the invention may be carried out in various ways and may take various forms and embodiments other than those illustrative embodiments heretofore described. Accordingly, it is to be understood that the scope of the invention is not limited by the details of the foregoing description, but will be defined in the following claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. Apparatus for scavenging organic gases from a partially evacuated environment comprising dissociator means for converting said organic gases into their molecular, parti-molecular, and atomic constituents, said dissociator means including a material selected from the group consisting of refractory oxides and catalysts, and scavenging pump means coupled to said dissociator means for selectively eliminating said constituents.

2. The combination defined in claim 1 wherein said dissociator means includes a pyrolytic element and means further associated with said pyrolytic element for subjecting said organic gases to ionization adjacent said pyrolytic element.

3. The combination defined in claim 1 wherein said dissociator means further includes a pyrolytic element and materials selected from the group consisting of barium, calcium, strontium, and oxygen bearing compounds thereof, titanium, zirconium, and intermetallic compounds thereof.

4. The combination defined in claim 1 wherein said scavenging pump means includes means for collecting and forming a sorbing surface of carbon produced by said dissociator means.

5. The combination with an electron discharge device having an envelope and means within the envelope including an organic target and an electron beam impinging thereon for generating organic gases responsive to operation of said electron discharge device, of a scavenging system for scavenging organic gases from said envelope, said scavenging system comprising dissociator means for converting said organic gases into their molecular, parti-molecular, and atomic constituents, said dissociator means including a material selected from the group consisting of refractory oxides and catalysts, and scavenging pump means coupled to said dissociator means for eliminating said constituents.

6. The combination defined in claim 5 wherein said scavenging pump means includes means providing a surface onto which free carbon produced by said dissociating means from said organic gases can deposit to form additional self-replenishing sorption surfaces for sorbing others of said constituents.

7. The combination with an electron discharge device having an envelope and an organic target in said envelope arranged to be bombarded by an electron beam, of a scavenging system for scavenging organic gases from said envelope, said scavenging system comprising dissociator means for converting said organic gases into their molecular, parti-molecular and atomic constituents, said dis-

sociator means including a material selected from the group consisting of refractory oxides and catalysts, and scavenging pump means coupled to said dissociator means for absorbing said constituents.

8. The combination with a gas scavenging pump of the ionic type including an ionization chamber for receiving gases to be scavenged, means for emitting electrons into the ionization chamber for collision with gas particles therein to form ions, and a surface of a material sputterable by ion bombardment to bury ions, of a gas flow passage for admitting gases to be scavenged into said ionization chamber, and organic molecule dissociating means arranged in said passage in the path of gases flowing into said ionization chamber.

9. The combination defined in claim 8 wherein said dissociating means includes pyrolytic means situated between the entrance of said flow passage and said ion pump and molecular filter means situated between the entrance of said flow passage and said pyrolytic means, said molecular filter means including a charge of a material from the group consisting of the zeolites, activated alumina, and activated charcoal.

10. The combination defined in claim 8 wherein said dissociating means includes a porous ceramic member arranged for flow of entering gases therethrough, and means for heating said ceramic member to a temperature sufficient to produce thermal dissociation of entering gases upon contact therewith.

11. The combination defined in claim 8 wherein said dissociating means includes a pyrolytic element, and means for catalyzing dissociation of gases exposed to said pyrolytic element.

12. The combination defined in claim 8 wherein there is also disposed in the gas flow passage between said dissociation means and said ionization chamber additional scavenging means for dissociating gas constituents consisting of materials from the group comprising barium, calcium, strontium, oxygen bearing compounds of barium, calcium and strontium, titanium, zirconium, and intermetallic compounds thereof.

13. A gas scavenging system for gettering an electron discharge device including an organic target and an electron beam impinging thereon, said system comprising an ion pump, a gas flow passage connected at one end to the ion pump and adapted to be connected at its other end to the interior of the electron discharge device envelope, and gas dissociating means disposed in said gas flow passage for decomposing gases exposed thereto into molecular, parti-molecular, and atomic constituents, said dissociator means including a material selected from the group consisting of refractory oxides and catalysts.

14. Apparatus for scavenging organic gases from a partially evacuated environment comprising dissociator means including a pyrolytic element for converting said organic gases into their molecular, parti-molecular, and atomic constituents, and scavenging pump means coupled to said dissociator means for selectively eliminating said constituents, said dissociator means being located between said scavenging pump means and the source of gases to be scavenged so as to substantially isolate said scavenging pump means from non-dissociated gases.

15. The combination defined in claim 1 wherein said refractory oxides are porous.

16. The combination defined in claim 1 wherein said refractory oxides are selected from the group consisting of beryllium oxide and aluminum oxide.

17. The combination defined in claim 14 wherein said pyrolytic element is coated with aluminum oxide.

18. The combination defined in claim 1 wherein said catalysts are noble metals.

19. The combination defined in claim 1 wherein said catalysts include a material selected from the group consisting of platinum and palladium.

20. The combination in claim 1 wherein said catalysts include a material selected from the group consisting of

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activated alumina, activated silica, activated magnesium oxide, activated carbon and activated aluminum silicate.

21. Apparatus for scavenging organic gases from a partially evacuated environment comprising dissociator means for converting said organic gases into their molecular, parti-molecular, and atomic constituents, said dissociator means including gas molecule decomposing means and molecular filter means situated between the decomposing means and the source of said organic gases, and scavenging pump means coupled to said dissociator means for selectively eliminating said constituents.

22. The apparatus as set forth in claim 21 further including means for cooling said molecular filter means.

23. The apparatus as set forth in claim 21 further including means for cooling said molecular filter means including a Peltier junction.

24. The apparatus as set forth in claim 21 wherein said filter means includes a charge of material selected from the group consisting of zeolites, activated alumina, and activated charcoal.

25. The apparatus as set forth in claim 21 wherein said scavenging pump is an ion pump.

26. The combination with an electron discharge device

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having an envelope and means including an organic target and an electron beam impinging thereon within the envelope for generating organic gases responsive to operation of said electron discharge device, of a scavenging system for scavenging organic gases from said envelope, said scavenging system comprising dissociator means for converting said organic gases into their molecular, parti-molecular, and atomic constituents, said dissociator means including gas molecule decomposing means and molecular filter means situated between the source of said organic gases and said gas molecule decomposing means, and scavenging pump means coupled to said dissociator means for eliminating said constituents.

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