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D. ALPERT
ISOLATION TRAP
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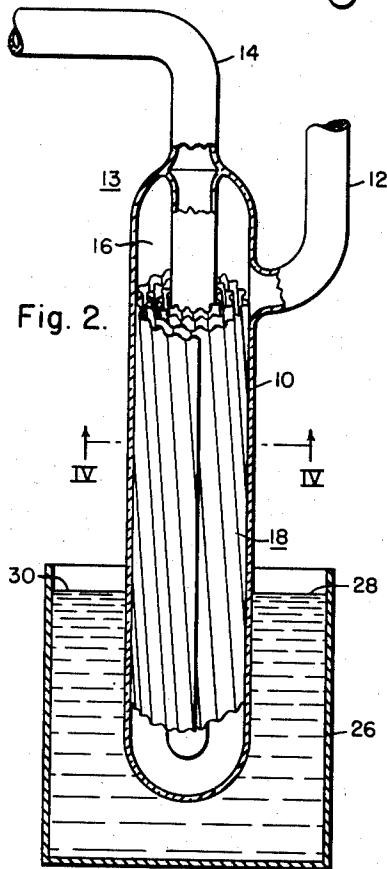
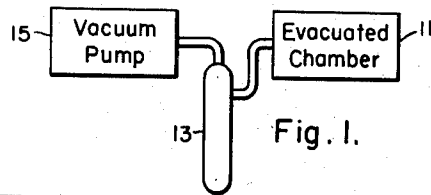


Fig. 2.

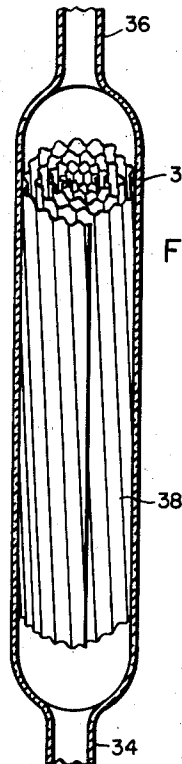
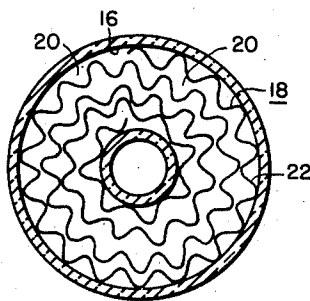


Fig. 3.

Fig. 4.



WITNESSES

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1

2,831,549

ISOLATION TRAP

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This invention relates to an improved isolation trap for removing vapors from a gaseous stream.

In accordance with prior art, evacuating systems employing mercury or oil diffusion pumps have been found to be capable of reducing and maintaining the pressure of the evacuated system to less than 10^{-3} mm. mercury. In order to further reduce the pressure of the system, it has been found necessary to prevent the oil or mercury vapors from diffusing or back-streaming into the system to be evacuated. This has been accomplished by interposing a trap in the path between the pump and the system to be evacuated. There have been several types of traps employed for this purpose but they have been found to have various limitations and the pressure obtainable has only been approximately 10^{-7} mm. mercury.

In particular, one embodiment of my invention is directed toward a type of trap which is commonly called a re-entrant cold trap and is fully described on page 75 of "A Manual of Vacuum Practice," by L. H. Martin and R. D. Hill, published by the Melbourne University Press. Essentially, this cold trap comprises an elongated cylindrical envelope of glass with an axially located glass inlet tubular member disposed partially within the envelope and sealed through the wall of the upper portion of the envelope. The tubular member is open on both ends, the lower portion of which extends into the lower region of the interior of the envelope and the upper portion is connected to the pumping system. An outlet opening is also provided through the wall on the upper portion of the envelope which is connected to the system to be evacuated. The outer surface of the lower portion of the envelope is cooled to a low temperature by immersion in a suitable refrigerant such as liquid air or solid carbon dioxide and acetone. This type trap operates on the theory of condensing the vapor molecules out onto the cool surface of the interior of the envelope and the tubular member. In practice it has been found almost impossible without making an expensive liquid level control system to maintain the level of refrigerant around the envelope. As a result, a drop in the level of the refrigerant permits the upper portions of the walls of the envelope and also the surface of the tubular member which had previously obtained a low temperature due to the refrigerant to warm up. As a result of this warming up, the vapors which were condensed onto the cooled surface re-evaporate and find their way into the system to be evacuated, thus destroying the full effectiveness of the trap. Also, a molecule of condensable vapor may proceed through the trap after a small number of collisions with the walls if the probability of sticking to the cool surface is not high. That is, if on the average it requires several collisions with the surface before a molecule sticks, the geometry of a standard re-entrant trap is such that an appreciable number of such molecules will go right through the trap.

It has also been found to be dangerous to utilize liquid air which is essentially liquid oxygen as the refrigerant in that there is a great danger of explosion if the envelope should break and the oil vapors come in contact with the

2

liquid air. Similar danger is possible even if liquid N_2 is used since it may liquefy some of the O_2 from the atmosphere with similar results.

It is, accordingly, an object of my invention to provide an improved isolation trap for vacuum systems.

It is another object to provide an improved type trap which shall be relatively insensitive to the variation in the level of the refrigerant in which it is immersed.

It is another object to provide an improved type trap which shall avoid any danger of explosion.

It is another object to provide an improved trap that is capable of operation in combination with an oil diffusion pump without the use of any refrigerant.

These and other objects are effected by my invention as will be apparent from the following description taken in accordance with the accompanying drawing, throughout which like reference characters indicate like parts, and in which:

Figure 1 shows an evacuating system;

Fig. 2 is a perspective view of a re-entrant type cold trap partially immersed within a refrigerating liquid embodying my invention;

Fig. 3 is a straight type trap embodying my invention; and,

Fig. 4 is a cross sectional view taken along the line IV—IV of Fig. 2.

Referring in detail to Figs. 1, 2 and 4, the re-entrant type trap 13 shown is comprised of a closed elongated cylindrical container or envelope 10 of suitable material such as glass. Positioned on the upper portion of the envelope 10 there is provided an outlet pipe or tubing 12 which is sealed into the wall of the envelope 10. The outlet tubing 12 is connected to the chamber or device 11 to be evacuated. Centrally or axially disposed within the envelope 10 is a tubular member 14 of a suitable material such as glass which is sealed to the upper portion of the envelope 10. The tubular member 14 is open on both ends and the lower portion disposed within the envelope 10 so that the lower opening of the tubular member 14 is positioned in the lower region of the interior of the envelope 10. The upper opening of the tubular member is connected to the pumping system 15. The annular region or space 16 which is formed between the walls of the tubular member 14 and the walls of the envelope 10 is filled with a suitable perforated thermal conductive member 18. In the specific embodiment shown, the member 18 which fills the annular region 16 is comprised of a continuous spiral of corrugated copper foil. This forms, in effect, as shown in Fig. 4, a system of small diameter copper straws or tubes 20 which completely fill the annular region 16. The corrugated foil member 18 may be fabricated from OFHC copper sheet 0.003 inch thick and 6 inches wide. The corrugations 22 in the sheet 18 may be obtained by passing a flat sheet of material between two matching sections of gear stock backed by 1 inch diameter cold-rolled steel rolls. It is desirable to form the corrugations 22 at an angle with respect to the direction of the copper sheet to create a more devious path through the member 18 as shown in Fig. 2. The resulting material 18 has the corrugations 22 approximately .025 inch deep and when rolled up forms passages 20 approximately .050 inch diameter.

One limitation on the design of traps is the fact that any trap will reduce the effective speed of pumping and it is therefore important to use a trap which shall have maximum practical conductivity. I have found that a cylindrical tubing 2.8 centimeters in diameter completely filled with copper foil such as previously described has approximately the same conductance as an unfilled tube of the same length 1 centimeter in diameter. For a reentrant trap whose interior tube 14 diameter is approximately one-third of the outer diameter of the envelope 10, the con-

ductance is reduced by only a factor of two through the introduction of the copper foil member 18. The copper foil member 18 represents an extensive surface area and a large effective ratio of length to diameter for each passageway 22 through the member 18. Although I described only one structure for member 18, this invention is not limited thereto. It is only necessary that the material of the member be of high heat conductivity and suitable for withstanding bake out. The member 18 may be of any configuration limited only in that it is permeable to gas.

In the installation of the trap, as described within a vacuum system as described in Figs. 1 and 2, the inlet opening to the trap consisting of the tubular member 14 is connected to the diffusion pump side of the system while the outlet opening in the trap consisting of the pipe 12 is connected to the side of the system to be evacuated. It is then customary after the system is reduced to pressure of the order of 10^{-2} mm. mercury to place a pot 26 containing the refrigerant 28 at a level 30 around the lower portion of the envelope 10.

In the operation of the device, the oil or mercury molecules diffuse from the pump 15 into the inlet tubular member 14 and pass to the lower region of the envelope 10 and then diffuse or pass up through the copper foil member 18 and are trapped within the trap before they can go into the outlet pipe 12. As previously mentioned with respect to prior designed traps, the dropping of the level of the refrigerant liquid resulted in the re-evaporation of the oil molecules condensed on the previously cold surfaces of the envelope 10 and the tubular member 14 as the level of the refrigerant dropped. In my device the high thermal conductivity of the material within the annular region 16 insures that the entire trapping surface remains cool and is essentially independent of the normal variations in the level of the refrigerant liquid. This is true in that regardless of the level 30 of the refrigerant 28, a portion of the member 18 will be below the level 30 of the refrigerant 28.

The use of the high thermal conductivity material 18 insures that the entire surface of the material will be held at substantially the same temperature which is essentially dependent on the temperature of the refrigerant. Although the material 18 comprises essentially the entire area onto which the vapors condense, there will be a small portion on the envelope 10 and the tubular member 14. Since the members 10 and 14 are of glass material of poor thermal conductivity, the effective condensing surface will be limited to the surface below the level of the refrigerant 28. The trap insures that there will be no re-evaporation of vapors from the members 10 and 14. The metal type trap has a particular advantage for use with mercury type pumps. The mercury has a greater probability of sticking to a cold metallic surface than to a cold glass surface. This is especially true in the case of metals with which mercury amalgamates, such as copper and silver. Thus the trap is uniquely suited as a cold trap for isolating Hg from adjoining containers or vacuum systems.

One of the unusual properties discovered of the trap described in Figs. 1 and 2 was found to be in its effectiveness for isolating the system to be evacuated from pumps using an organic liquid such as octoil or octoil-S, generally referred to as oil pumps, even while the trap is held at room temperature. It was found that after a high temperature bakeout or outgassing at a temperature of 400 to 500° C. for a period of one to ten hours with a vacuum of pressure of 10^{-3} mm. mercury along with the rest of the system in the evacuating cycle that a low pressure was obtainable with further pumping even without the refrigerant applied to the trap. The trap may be baked out separately while on the system at a temperature of about 300° C. It is necessary to bake a charcoal trap out at a temperature of 700° C. and the pressure obtained was only of the order of 10^{-8} mm. mercury. I have been

able to obtain a pressure of about 10^{-11} mm. mercury without the use of any cooling medium around the trap described herein.

As a result of this feature, it is seen that a trap may alternatively be designed substantially in the straight through type form as shown in Fig. 3. The device shown in Fig. 3 is comprised of an elongated tubular member 32 having an inlet opening 34 and an outlet opening 36 at opposite ends of the member 32 and a high thermal conductivity type member 38 positioned within the tubular member 32. The member 38 may be of similar structure to the member 18 previously described and is wound to fill the tubular member 32 between the openings 34 and 36.

It has been found possible to obtain and maintain a pressure of 10^{-11} mm. mercury for a week or more in a vacuum system isolated from the oil pump by the trap held at only room temperature. The composition of the material of the member 18 or 38 utilized in a trap at room temperature must be of suitable melting point metal or alloy such as copper, an alloy comprising 80% nickel, 15% chromium and 5% iron (such as that sold under tradename, Inconel), nickel, silver titanium, iron and bronze. The operation of the room temperature trap has been found to be especially good with respect to copper and Inconel. It is believed that this material exhibits the property of preferential sorption for the impurities coming from oil diffusion pumps when the surface is clean. The term clean is defined to mean "desorbed" of surface layers of gas. This is achieved by bake-out at temperatures above 300° C. for a sufficient interval to remove said layers. The term "sorption" is defined to indicate either the removal of gas and vapors by absorption or adsorption to distinguish from the condensing property of the cold trap. It also has been found that by using a metal that has a lightly oxidized surface and then reducing with hydrogen prior to bakeout substantially increases the effectiveness of the trap and the length of time it will continue to capture oil molecules. This process produces a microscopically irregular surface. It is found that after several days of operation that the vacuum obtained of the order of 10^{-11} mm. mercury is gradually reduced to the order of 10^{-8} mm. mercury depending on the amount of surface available in the material 18 or 38.

While I have shown my invention in two forms, it will be obvious to those skilled in the art that it is not so limited but is susceptible of various changes and modifications without departing from the spirit and scope thereof.

I claim as my invention:

1. In a high vacuum system, in combination with a high vacuum pump, a high vacuum vapor trap comprising a substantially evacuated envelope having therein an inlet and an outlet opening and a clean metallic member composed of a substance which is substantially impervious to gas molecules and which may be heated above 300° C. without melting, said member being in the form of a metallic corrugated spiral sheet so that said member has a plurality of penetrating passageways, said member substantially filling the region between said inlet and outlet openings.

2. In a high vacuum system, in combination with a vacuum pump, a high vacuum vapor trap comprising a substantially evacuated envelope having therein an inlet and an outlet opening and a clean metallic corrugated spiral sheet member substantially filling the region between said inlet and said outlet openings, said metallic members being composed of a substance which is substantially impervious to gas molecules, said member having a plurality of penetrating passageways, said metal member being conditioned by being baked out at a temperature of about 300° C. without melting within said vacuum system.

5

3. In a high vacuum system, in combination with an oil diffusion vacuum pump, a high vacuum vapor trap comprising an elongated substantially evacuated enclosure having an inlet opening and an outlet opening, means whereby oil is unavoidably diffused from said pump to said trap and means to remove said oil by sorption, said removing means comprising a clean metallic member positioned within said enclosure, said metallic member being capable of preferential sorption of oil molecules from said pump, said metallic member being composed of a substance which is substantially impervious to gas molecules and which may be heated above 300° C. without melting, said metallic member having a plurality of penetrating passageways and said member substantially filling the region between said inlet and outlet openings.

4. In a high vacuum system, in combination with an oil diffusion vacuum pump, a high vacuum vapor trap comprising an elongated cylindrical substantially evacuated envelope having an inlet opening and an outlet opening positioned at opposite ends of said envelope, means whereby vapors are unavoidably diffused from said pump to said trap and means to remove said vapors by sorption, said removing means comprising a spiral wound corrugated metallic foil member positioned within said envelope, having a plurality of penetrating passageways, and substantially filling the region between said inlet and outlet openings, said foil member being characterized in that the surfaces are clean and are capable of preferential sorption of vapors from said pump, said foil member being composed of a substance which is substantially impervious to gas molecules and which may be heated above 300° C. without melting.

5. In a high vacuum system, in combination with a high vacuum pump, a high vacuum vapor trap comprising a substantially evacuated envelope having an upper portion and a lower portion, an inlet tubular member connecting with said upper portion of said envelope and extending downward through said envelope to said lower portion, said tubular member forming with the wall of said envelope an annular region, an outlet opening in said upper portion of said envelope, means whereby vapors are unavoidably diffused from said pump into said vapor trap, and means to remove said vapors by sorption, said removing means comprising a clean metallic member being composed of a substance which is substantially impervious to gas molecules, which may be heated above 300° C. without melting, and which has a high thermal conductivity, said metallic member having a plurality of penetrating passageways, said metallic member substantially filling said annular region.

6. In a high vacuum system, in combination with a high vacuum pump, a high vacuum vapor trap comprising a substantially evacuated envelope having an upper portion and a lower portion, an inlet tubular member connecting with said upper portion of said envelope and extending downwardly through said envelope to said lower portion, said tubular member forming with the wall of said envelope an annular region, an outlet opening in said upper portion of said envelope, a clean metallic member substantially filling said region, said clean metallic member being composed of a substance which is substantially impervious to gas molecules, which may be heated

6

above 300° C. without melting, and which has a high thermal conductivity, said metallic member being in the form of a corrugated spiral sheet so that said member has a plurality of penetrating passageways.

7. In a high vacuum system, in combination with a high vacuum pump, a high vacuum cold vapor trap comprising a substantially evacuated envelope having an upper portion and a lower portion, said lower portion being adapted to be immersed in a cooling medium, an inlet tubular member connecting with said upper portion of said envelope and extending downwardly through said envelope to said lower portion, said tubular member forming with the wall of said envelope an annular region, an outlet opening in said upper portion of said envelope, means whereby vapors are unavoidably diffused from said pump to said trap, and means to remove said vapors comprising a clean metallic member substantially filling said region, having an extensive surface area and having a plurality of penetrating passageways, said clean metallic member being composed of a substance which is substantially impervious to gas molecules, which may be heated above 300° C. without melting, and which has a high thermal conductivity.

8. An evacuating system comprising, in combination, a chamber to be exhausted, an organic liquid diffusion vacuum pump, a conduit means forming a passage between said chamber and said pump, whereby organic liquid vapors are unavoidably diffused from said pump along said conduit means and means for removing said organic vapors by sorption, said removing means comprising a high vacuum vapor trap, said trap including a substantially evacuated envelope having an inlet opening and an outlet opening, said trap also including a clean metallic member capable of preferential sorption of organic vapors from said pump, said metallic member being composed of a substance which is substantially impervious to gas molecules and which may be heated above 300° C., without melting, said metallic member having a plurality of penetrating passageways and substantially filling the region between said inlet opening and said outlet opening, said metallic member having an extensive surface area.

9. In a high vacuum system, in combination with a high vacuum pump, a high vacuum vapor trap comprising a substantially evacuated envelope having an inlet opening and an outlet opening and a clean metallic member of extensive surface substantially filling said envelope, said surface area being conditioned by the steps of oxidation, reduction and cleaning, said metallic member being in the form of a corrugated spiral sheet so that said member has a plurality of penetrating passageways, said member being composed of a substance which is substantially impervious to gas molecules and which may be heated above 300 C. without melting.

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