July 16, 1968 J. J. KING, JR 3,392,511

WATER VAPOR ABSORBER

Filed July 13, 1967

Fig. 1

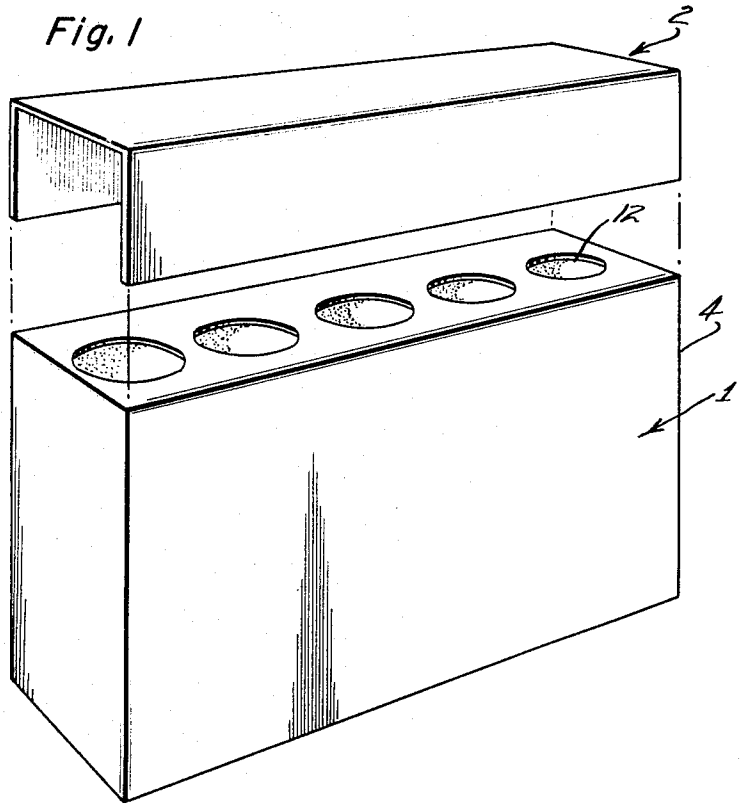
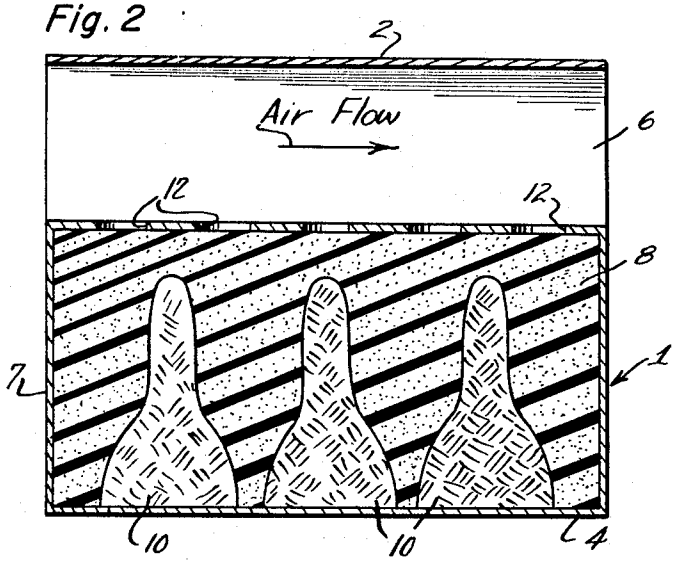


Fig. 2



Jesse J. King, Jr.
INVENTOR.

BY John F. Miller
Agent

United States Patent Office 3,392,511 Patented July 16, 1968

3,392,511

WATER VAPOR ABSORBER

Jesse J. King, Jr., Dallas, Tex., assignor, by mesne assignments, to the United States of America

Filed July 13, 1967, Ser. No. 653,279
2 Claims. (Cl. 55—388)

ABSTRACT OF THE DISCLOSURE

Alternate layers of compressed sponge and dry lithium chloride powder are packed in a container arranged to direct a flow of air over a surface of the sponge which is wetted with lithium chloride solution. Moisture is transferred from the air flow through the sponge to the lithium chloride powder which enters into solution. The sponge absorbs this solution, expanding to fill the container and preventing any flow of the liquid which might result from a weightless environment. This avoids the complexities of the prior art systems.

Background of the invention

The invention is in the field of water removal systems for a weightless environment. In the prior art metal and filter discs stacked alternately around a refrigerant conducting tube and in a vacuum have been used for water removal. A layer of loosely compressed absorbent material above a layer of tightly compressed absorbent material in a container with pressure responsive valves to maintain a pressure differential has been tried. Combinations of sponges and desiccant materials in a container have been tried. However, the weight and complexities of valves, pumps, and accessory paraphernalia have hampered the use of the more elaborate systems and inefficiency has restricted the employment of the simpler systems.

Summary of the invention

A system for removing water from the atmosphere which is particularly suitable for a weightless environment such as inside a space ship. It is comprised of layers of dry lithium chloride powder alternating with layers of partially compressed sponge in a container which is arranged to direct an air flow over a surface of the spronge wetted with lithium chloride solution. Moisture is transferred from the air through the sponge to the lithium chloride which goes into solution. The sponge expands to fill the container, occupying the space formerly occupied by the lithium chloride powder and absorbing the liquid solution. The solution is held in the small interstices in the sponge by capillary action independent of gravity. This prevents the undesired flow of liquid in a weightless environment with the simplicity and efficiency which are primary objects of the invention.

Brief description of the drawings

FIG. 1 shows an exploded view of a container of the invention with the cover of the upper compartment raised.

FIG. 2 is a longitudinal cross-sectional view of a container of the invention with the cover of the upper compartment in place.

Description of the preferred embodiment

The invention as shown in FIGS. 1 and 2 comprises a container **1** which is divided into two compartments **6** and **7**. Compartment **6** is an air duct formed by an outer shell **2** and through which a controlled flow of air is directed. An adjacent compartment **7** is formed by an outer shell **4** and is packed with alternating layers of desiccant material **10** and a compressible absorbent material **8**. The layers of material **8** are longer than the layers of material **10** so that a surface of material **8** bears against air duct **6**. Openings **12** in shell **4** allow the air flow in duct **6** to contact the compressible absorbent material **8** in compartment **7**. The relative volumes and configuration of compartment **7** and the layers of materials **8** and **10** with which it is packed are selected so that the layers of compressible absorbent material **8** are initially somewhat compressed. In FIG. 2, the lower parts of the layers of material **8** between the layers of material **10** are shown as being more compressed than the upper parts. The reasons for this will be explained hereinafter.

In use, a controlled flow of air is directed through duct **6** and passes over those parts of compressible absorbent material **8** exposed through opening **12**. Moisture in the stream of air is absorbed by material **8** and part of this moisture is in turn absorbed by material **10**, or depending on the materials selected, material **10** might be said to absorb moisture through material **8**. If desiccant **10** is of such nature that it changes volume when water is absorbed, the compressible absorbent material expands and/or contracts as necessary to keep the combined volume of materials **8** and **10** constant.

The great advantage of this arrangement is that it makes possible the use of superior desiccants such as, for example, lithium chloride, which can absorb 1.26 pounds of water per pound of lithium chloride. Since it is deliquescent it is difficult to use in prior art water absorber devices when employed in a weightless environment such as in a space ship. This is so because the liquid solution of lithium chloride tends to flow, blocking air passageways and, being unrestrained by gravity, tends to float around in the ship. In a preferred embodiment of the invention, fine pore cellulose acetate sponge was selected as the compressible absorbent material **8** because of its superior wicking and absorption qualities, and lithium chloride was selected as the desiccant material. The sponge stores water utilizing the capillary effect along small interstices within itself. This surface tension effect is independent of gravity. Lithium chloride crystals have low bulk density and upon absorbing water and attaining a state of $LiCl\text{-}1H_2O$ tend to pack or coalesce initially to a volume approximately one-half that of dry lithium chloride powder. As more water is absorbed, more powder enters into solution, and the volume expands to about one-third more than the volume of the dry powder. This represents a fully saturated solution ($LiCl\text{-}3H_2O$) which is in equilibrium at room temperature with a surrounding atmospheric relative humidity of approximately 11%. If the apparatus is then supplied with a flow of air having relative humidity greater than 11%, for example in a space ship environment, the lithium chloride solution will continue to absorb water from the air. As additional water is absorbed the volume of solution continues to increase until the maximum moisture retention state ($LiCl\text{-}12H_2O$) is reached.

If the container volume is selected to equal the final volume of a lithium chloride solution of a selected degree of saturation plus an allowance for solids composing the sponge matrix, as the lithium chloride enters into solution the sponge layers being initially compressed, can expand and absorb the solution through inherent wicking action. The original sponge volume should be such that the sponge will absorb all of the solution and fill the entire container. This prevents any sloshing of the liquid LiCl solution in the container and the small sponge cavities retain the solution so that flowing to other parts of the space ship is prevented. FIG. 2 shows the upper parts of the layers of material **8** expanded more than the lower parts, indicating a state wherein the upper parts of desiccant **10** layers have absorbed some moisture resulting in some of the desiccant **10** going into solution and being absorbed by the expanded sponge. The upper parts are

affected before the lower parts because of the proximity of air duct 6. In the preferred embodiment the sponge is pre-wetted with some lithium chloride solution to expedite the transfer of moisture from the air stream.

The configuration shown by way of example is for simplicity of illustration. Other configurations, e.g., a shaped canister surrounding a perforated tubular air duct, etc., may be used to fit a particular application, without departing from the invention. The degree of sponge compression employed is a function of the materials selected and can readily be determined in the light of the above teachings. Other desiccants and compressible materials can be selected. Therefore, the invention is not confined to the exemplary embodiment shown but is limited only by the following claims.

What is claimed is:

1. In a water vapor absorber apparatus, the improvement comprising:

a container, a perforated air duct through said container, alternating layers of absorbent compressible material and desiccant material arranged in said container in such manner that the innermost portions of said layers of absorbent compressible material form a layer adjacent said air duct, and interposed between said air duct and the innermost portions of said layers of desiccant material so that moisture may be transferred from the air flow through said air duct to the said layers of desiccant material through said adjacent layer and said layers of absorbent compressible material, the dimensions of said container, air duct, and alternating layers being such that said absorbent compressible material is initially compressed to such degree as to be further compressible and/or expandable to compensate for changes of volume in the desiccant material caused by absorption of moisture by said layers of desiccant material, and to absorb any solution of desiccant material resulting from absorption of moisture by said layers of desiccant material, whereby said solution is held in the interstices of said layers of absorbent material by capillary effect, independent of gravity, thereby preventing slosh or creep of said solution, even in a weightless environment.

2. The apparatus of claim **1**, wherein said absorbent compressible material is cellulose acetate sponge and said desiccant material is lithium chloride.

References Cited

UNITED STATES PATENTS

1,383,247	6/1921	Smith et al.	55—388 X
1,798,862	3/1931	Baker	55—388 X
1,920,914	8/1933	Poggel	55—388
2,792,071	5/1957	Pennington	55—233 X
3,221,478	12/1965	Norton	55—388 X

FOREIGN PATENTS

437,139	10/1935	Great Britain.

REUBEN FRIEDMAN, *Primary Examiner.*