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Frank et al.

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[54] HELIUM PERMEABLE CONTAINERS

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 454,542, May 10, 1965, abandoned.

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[51] **Int. Cl.**.....**G21c 13/00**

[58] **Field of Search**.....176/79; 250/84.5; 29/182.5, 29/183, 191.2; 75/200 F; 313/180; 161/158, 143

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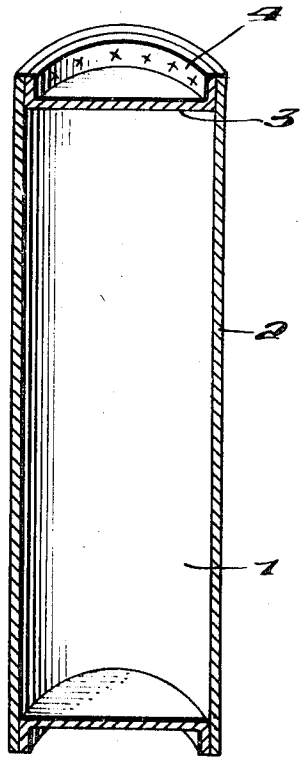
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[57] **ABSTRACT**

An alpha-emitting radioisotope source container which allows for the controlled release of helium gas without permitting any radioactive material to escape, the container being a metal-fiber composite of helium impermeable metallic wall means with helium permeable quartz fibers reinforcing the wall means and extending continuously through at least a portion of said wall means and providing a fibrous helim leak path.

16 Claims, 1 Drawing Figure


4
3
2
1

HELIUM PERMEABLE CONTAINERS

This invention relates to a technique for allowing helium gas, the product of alpha emitting radioisotopes used in nuclear power sources, to escape from its container without permitting the radioactive material to be released; and is a continuation-in-part of our application, Ser. No. 454,542, filed May 10, 1965, and now abandoned.

Radioactive isotopes whose decay heat is converted to electricity by thermoelectric or thermionic converters are used in compact, high output, energy devices. Alpha particle emitting isotopes are desirable heat sources because of their high thermal outputs, and ease of handling from a safety viewpoint. Alpha sources do have serious limitations when one considers the buildup of gas pressure within the source container as the decaying isotope emits alpha particles which are helium nuclei. This continuous pressure buildup limits the life of the radioisotope device since the creep resistance of the container material operating at elevated temperatures, can be exceeded and the container can rupture. The use of a void volume within the container or venting of the container have been suggested as methods for circumventing the helium buildup problems. Both of these methods compromise the objectives of compactness, simplicity, and safety is radioisotope devices.

The principal object of this invention is to be able to construct alpha emitting radioisotope source containers which allow for the controlled release of helium gas without permitting any radioactive material to escape from the container. This controlled release of helium gas will permit one to adjust the internal container pressure to any desired level.

A further object and advantage of this invention is that the means of providing helium permeation through the container can also be used to strengthen the container.

The FIGURE of drawing illustrates one shape of a container made in a form to carry out this invention.

The container can be in any form but is shown for purposes of illustration, in the form of a tubular member **2**, surrounding radioactive material space **1**. Container **2** has an end wall **3** formed to be placed inside of tubular member **2** and secured in sealed relationship with member **2** around the periphery thereof by welding or other forms of continuous bond as shown at **4**.

The objective can be achieved by incorporating in the container material a substance through which helium may permeate and said substance will be in such a form as to enhance the strength of the container. Fused quartz in the form of fibers distributed in the container material is the type of substance which can provide the helium leak path and strength improvement to the container. The fibers should be continuous through the material of the wall from the inside to the outside thereof.

While most constructional materials have been known to be impermeable to helium, the use of glasses in ultrahigh vacuum systems has indicated helium permeation through glasses. Helium diffusion through glasses has been measured and the permeation velocity constant K has been experimentally determined. The following table presents the helium permeation constants at various temperatures of fused quartz (100 percent SiO_2) which has the highest measured permeation rate.

	T °C.	K
Fused Silica (Amersil)	25	1.2×10^{-10}
	25	1.2×10^{-10}
	169	1.5×10^{-9}
	175	1.7×10^{-9}
	313	6.4×10^{-9}
	470	1.4×10^{-8}
Fused Silica (G.E.)	25	1.0×10^{-10}
	161	1.3×10^{-9}
	333	6.4×10^{-9}
	485	1.7×10^{-8}

K, the unit of the permeation rate can be expressed as cc. (STP)/sec./cm.^{2} area/ mm. thickness/cm. Hg pressure difference.

It is seen from the above tabulation that it is possible to relieve the gas pressure in the interior of an alpha emitting container by providing helium permeable members through which helium is free to permeate. For a planar member, with pressure gradient p, cross-sectional area A, and thickness d, the quantity of gas q, per unit t, to pass through it is given by

$$q = K A (\Delta p) t/d$$

Knowing the permeation velocity constant K at a specific temperature, and the quantity of gas q being generated per unit time within a radioisotope container, it is possible to construct a container such as shown in the drawing, with helium permeable members such as quartz fibers with controlled cross-sectional area and thickness and thereby maintain any desired pressure within said container.

This type of construction is based on the technology known as fiber composites. Fiber composite structural components are prepared by incorporating high strength fibers into a ductile metal matrix and thereby reinforcing the strength of the matrix. This approach has been vary successful in improving the high temperature strength of metals by incorporating ceramic fibers in the body. Aluminum oxide whiskers in silver exhibit a tensile strength of nearly 45,000 p.s.i. at 1,400° F. which is more than 20 times that of pure silver.

The container construction proposed in this invention can be of practically any shape but for the purpose of illustrating an embodiment of a container is shown cylindrical in shape and consisting of quartz or other helium permeable materials in fibrous form incorporated into metallic alloys such as molybdenum, tungsten, tantalum, columbium, titanium, nickel or cobalt metals or their alloys based upon them or noble metals such as gold, silver or platinum or noble metal based alloys such as platinum-rhodium or platinum-iridium or platinum-osmium to form a composite. The cylindrical portions of the container can be prepared by aligning the fibers on a form or mandrel and then isostatically compacting the desired metal powder into it to form the composite. Metal spraying or other powder metallurgical techniques can also be employed to prepare the composite. The ends of the container can be prepared by conventional powder metallurgical techniques of compacting and sintering or hot pressing a mixture of aligned fibers and metal powders. Should proper alignment of fibers prove difficult it should be possible to orient the fibers by a working process such as rolling. The volume percent of fibers can be controlled to any desired amount, between 10–20 percent being most desirable. The thickness of the wall may be from 30 to 50 one-thousandths of an inch thick.

It is to be understood that certain changes, alterations, modifications and substitutions can be made in this invention without departing from the spirit and scope of the depending claims.

What is claimed is:

1. A metal-fiber composite container for helium generating radioisotopes, comprising helium impermeable metallic wall means for said container, and helium permeable quartz fibers integrally reinforcing the same, said reinforcing quartz fibers extending continuously through at least a portion of said wall means and providing a fibrous helium leak path.

2. The container of claim **1**, wherein said metallic wall means are comprised of a member selected from the group consisting of molybdenum, tungsten, tantalum, columbium, titanium, nickel, cobalt, alloys based upon the foregoing metals, noble metals, and alloys based upon the noble metals.

3. The container of claim **2**, wherein the metallic wall means are comprised of molybdenum.

4. The container of claim **2**, wherein the metallic wall means are comprised of tungsten.

5. The container of claim **2**, wherein the metallic wall means are comprised of tantalum.

6. The container of claim **2**, wherein the metallic wall means are comprised of columbium.

7. The container of claim **2**, wherein the metallic wall means are comprised of titanium.

8. The container of claim 2, wherein the metallic wall means are comprised of nickel.

9. The container of claim 2, wherein the metallic wall means are comprised of cobalt.

10. The container of claim 2, wherein the metallic wall means are comprised of a noble metal.

11. The container of claim 10, wherein the metallic wall means are comprised of gold.

12. The container of claim 10, wherein the metallic wall means are comprised of silver.

13. The container of claim 10, wherein the metallic wall means are comprised of platinum.

14. The container of claim 2, wherein the metallic wall means are comprised of platinum-rhodium.

15. The container of claim 2, wherein the metallic wall means are comprised of platinum-iridium.

16. The container of claim 2, wherein the metallic wall means are comprised of platinum-osmium.

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