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[54] NEUTRON-EMITTING TRITIATED TARGET HAVING A LAYER CONTAINING TRITIUM AND A PASSIVE SUPPORT WITH AN INTERMEDIATE BARRIER

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[51] **Int. Cl.** **G21g 3/00**

[58] **Field of Search** 250/84.5; 313/61

[56] **References Cited**

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[57] **ABSTRACT**

A neutron-tritiated target, comprising a layer containing a suitable quantity of tritium and a passive support in which the layer is thick enough to retard deuterons bombarding the target and is applied to the support by way of a thin intermediate barrier, formed of a metal in which hydrogen isotopes diffuse slowly and having a thickness such as to prevent the return of the deuterons from the support to the layer at the same time as the passage of the tritium towards the support.

4 Claims, 2 Drawing Figures

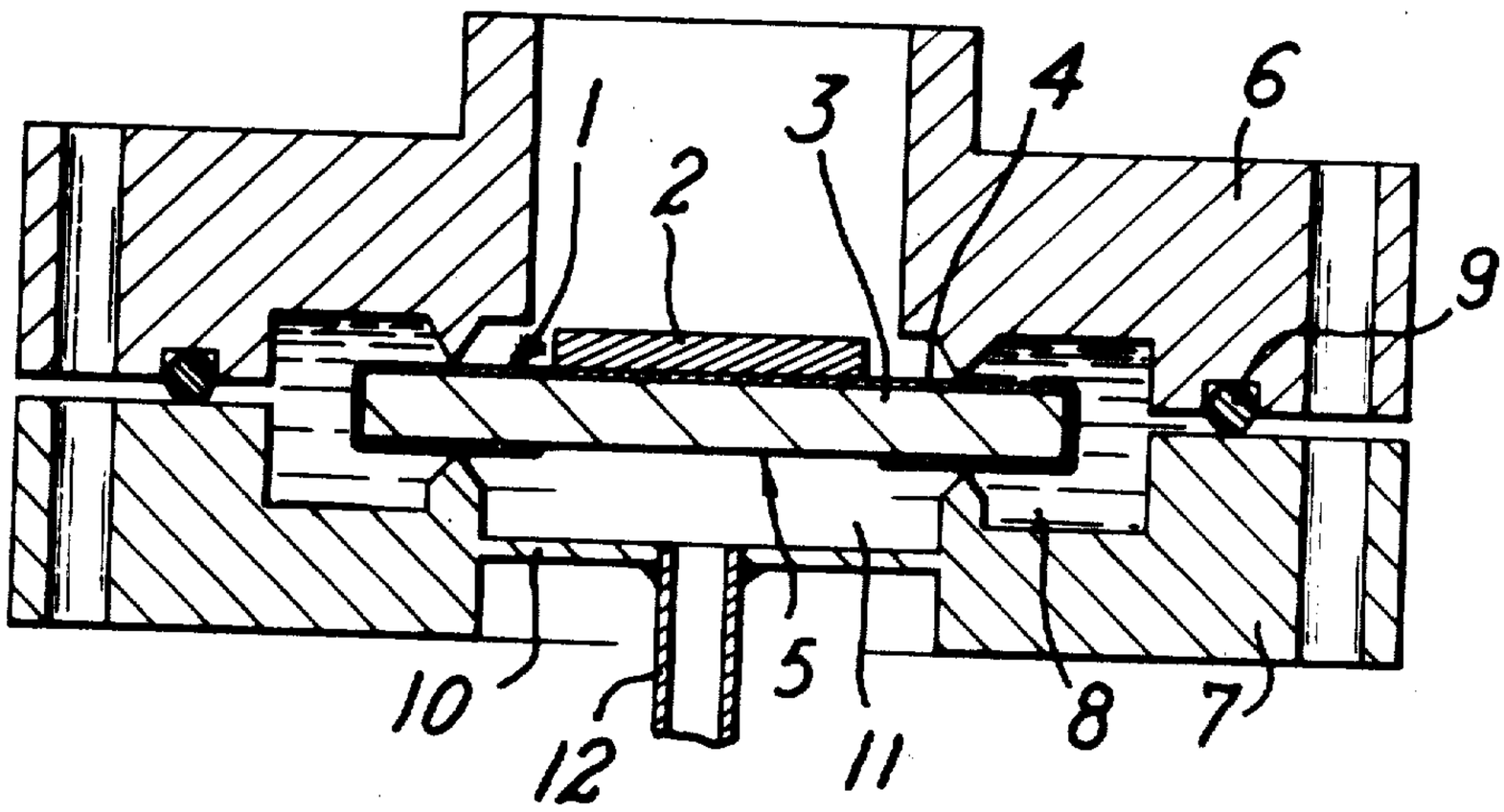


FIG. 1

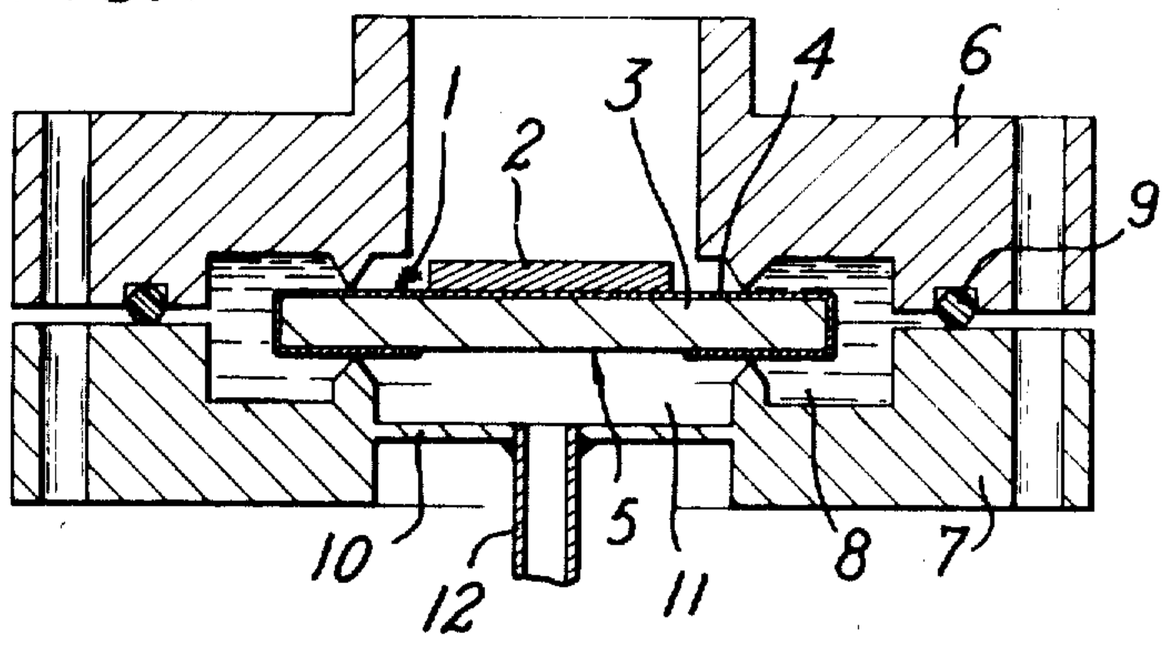
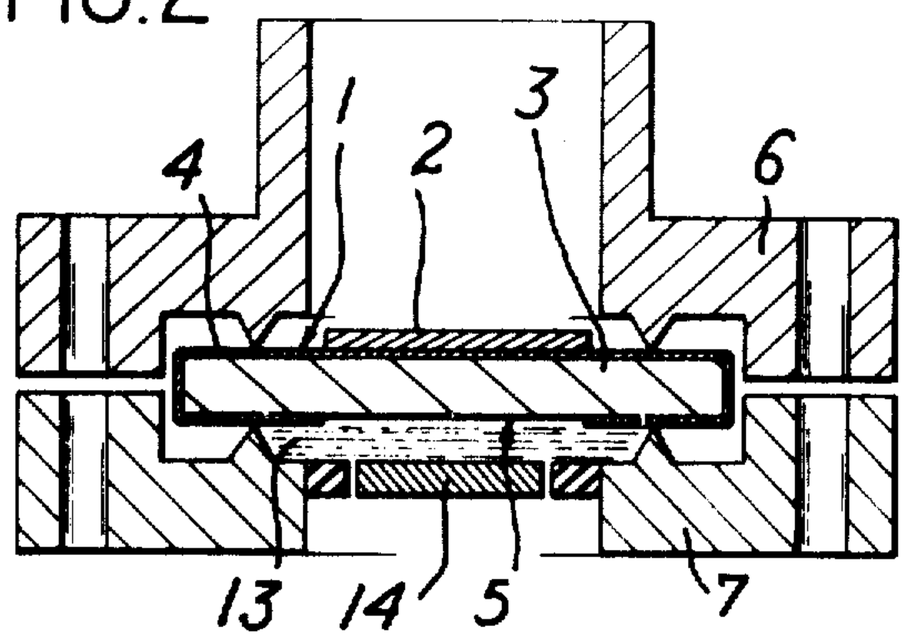


FIG. 2



NEUTRON-EMITTING TRITIATED TARGET HAVING A LAYER CONTAINING TRITIUM AND A PASSIVE SUPPORT WITH AN INTERMEDIATE BARRIER

The invention relates to targets containing tritium and bombarded by a beam of deuterons or deuterium atoms to produce fast neutrons as a result of the well-known reaction T (d, n)^4 He.

In known targets of this type, which generally have a passive nonhydrogenizable support bearing at least one layer of a tritiated metal, a hydride or a mixture of metal hydrides containing substantial proportions of tritium, there is rapid decomposition of the tritiated layer, generally termed the solid phase, due to passage of the tritium into the gaseous phase. This progressive reduction in the tritium content, caused by the replacement of tritium atoms by deuterium atoms from the incident beam, diffuses the tritium either into the passive support for the target or into the accelerator chamber and causes a corresponding, substantial drop in the rate at which neutrons are emitted. During continuous operation, the quantity of deuterium thus injected into the target is compensated because an equal quantity of a mixture of deuterium and tritium enters the gaseous phase, so that, in the solid phase, the hydrogen concentration remains constant. Over a period, therefore, this solid phase becomes depleted as regards tritium and enriched as regards deuterium.

The object of the invention is to provide a novel construction for neutron-emitting tritiated targets by means of which this disadvantage can be overcome, more particularly by reducing the quantity of deuterium incorporated in the solid phase, so substantially lengthening the life.

To this end, a neutron-emitting target according to the invention, comprising a layer of tritiated metal, a metal hydride or a mixture of hydrides containing a suitable quantity of tritium and a passive support for the layer, is characterized in that the layer is thick enough to retard the deuterons bombarding the target and is applied to the support by way of a thin intermediate barrier, this barrier being formed of a metal in which hydrogen isotopes diffuse slowly and having a thickness such as to prevent the return of the deuterons from the support to the layer at the same time as the passage of the tritium towards the support.

Advantageously, the intermediate barrier is made from one of the following metals: gold, silver, copper, aluminum etc., in which hydrogen isotopes diffuse very slowly.

According to a first variant, the passive support is formed of a metal which has good thermal conductivity, which is hydrogenizable and in which hydrogen isotopes diffuse rapidly, so that the deuterium which has passed through the thin layer and the barrier is retained.

In another variant, the support is made from a nonhydrogenizable metal mounted in a target carrier which holds the support at its periphery and has an annular cooling-water circuit, that face of the support remote from the layer partly defining a cavity in which a vacuum is produced in order to eliminate the deuterium which has traversed the support. Lastly, in another variant derived directly from that just specified, the face of the support remote from the layer is cooled by a solution which forms an electrolyte or a chemical reagent and causes the deuterium to be eliminated electrochemically or by means of a chemical reaction. Where the solution is an electrolyte, the support acts as the first electrode and the target carrier as the second electrode for electrolysis of the solution.

The following description, relating to two embodiments given by way of example only, illustrates in more detail the various features of neutron-emitting tritiated targets constructed in accordance with the invention.

In the accompanying drawings, FIGS. **1** and **2** are diagrammatic sectional views of neutron-emitting targets mounted in a target carrier, one for each of the two embodiments.

In these FIGS. in which like reference numerals designate like elements, the neutron-emitting tritiated target **1** has a thin surface layer **2**, containing an appropriate quantity of tritium

in any form desired. In particular, this layer **2** may be in the form of a tritiated metal, especially titanium, yttrium, a rare earth, etc., a hydride or a mixture of hydrides. In the latter case, a particularly advantageous arrangement is that described in our U.S. Pat. application No. 755,433 filed on Aug. 26, 1968.

The thickness of the active layer **2** is such that it necessarily causes the monokinetic deutrons in the incident beam bombarding the target to slow down to an energy of a few tens of Kev. In accordance with the invention, the layer **2** is deposited on a passive support **3**, an intermediate layer **4** being inserted between these two elements in order to form a diffusion barrier. This barrier **4** is made of a material in which the various isotopes of hydrogen (tritium and deuterium) diffuse slowly, e.g., gold, silver, copper, aluminum, etc. The thickness of the barrier is such that the incident deuterons which have traversed the tritiated layer **2** and have already been partly retarded by this layer are retarded only slightly. However, the barrier must be thick enough to permit suitable diffusion of these deuterons into the support **3**, mainly in order to prevent them returning to the layer **2** and also to prevent the tritium in this layer from moving in the direction of the support. Preferably, the barrier **4** is in the form of a thin film of one of the metals mentioned, with a thickness of the order of 100 μg./cm.^{2} to ensure a satisfactory compromise.

As regards the construction of the passive support **3**, two variants are possible, according to whether the deuterons which have passed through the layers **2** and **4** are to be retained in this support or eliminated as they appear through that face of the support remote from the face bearing the tritiated layer **2**.

In the former case, the passive support **3** is preferably made from a metal which has good thermal conductivity and is hydrogenizable, such as palladium and in which deuterons diffuse rapidly at the operating temperature of the target. The deuterons or deuterium atoms traversing the layers **2**, **4** then enter the support and diffuse through its thickness, causing progressive hydrogenization of it. The composition of the support therefore changes continuously throughout operation of the target, although the time taken to form the stable hydride richest in hydrogen may still be very long and at all events much longer than the life of the tritiated layer **2**. Advantageously, however, the rate at which deuterium diffuses through the barrier **4** is reduced to some extent to prevent deformation due to the increase in volume, which might, in particular, detach the thin layers **2**, **4**.

For this reason, in another variant illustrated in particular in FIGS. **1** and **2**, the concentration of deuterium atoms in the support **3** is kept down by continuously eliminating the deuterium through the face **5** of this support, i.e., the face remote from that bearing the barrier **4** and tritiated layer **2**. To this end, the target **1** is mounted in a target carrier formed of two adjacent elements **6**, **7** which grip the target between them by means of the vicinity of its periphery and define, with the edge of the target, an annular chamber **8** for receiving an appropriate coolant liquid. A seal **9** ensures fluidtightness between the elements **6**, **7**. In this embodiment, the face **5** of the support **3** partly defines, with a ledge **10** on the element **7**, a chamber **11** which is connected by a duct **12** to a vacuum pump (not shown), so that the pressure in this chamber **11** can be lowered, automatically eliminating the deuterium which has passed through the support.

In another embodiment, shown in FIG. **2**, the element **7** of the target carrier again cooperates with the face **5** of the support **3** to define a cavity **13**. This time this cavity is to receive a liquid solution, more particularly a chemical reagent or an electrolyte such as normal sulphuric acid. If the former, the deuterium absorbed is eliminated by means of a chemical reaction; if the latter, the deuterium is extracted electrochemically due to electrolysis of the solution, with the support **3** acting as the first electrode and a portion **14** of the target carrier opposite it acting as the second electrode.

In all cases, a neutron-emitting target is obtained in which elimination of the deuterium or diffusion of the deuterium into the support substantially restricts the speed at which the tritiated layer is enriched with deuterium at the expense of tritium, so greatly lengthening the total life of the target.

Obviously, the invention is by no means restricted to the embodiments particularly described and shown. On the contrary, it covers all variants of these embodiments.

I claim:

1. A neutron-emitting tritiated target comprising a metal layer selected from the group consisting of tritiated metal, metal hydride and a mixture of hydrides containing tritium, a passive support for the layer, the layer being thick enough to retard the deuterons bombarding the target, a thin intermediate barrier between the layer and the support for the layer, said barrier being a metal in which hydrogen isotopes diffuse slowly and having a thickness preventing the return of the deuterons from the support to the layer at the same time as the passage of the tritium towards the support, the barrier being selected from the group of metals consisting of gold, silver, copper, and aluminum, the passive support being a metal having good thermal conductivity and hydrogenizable in which hydrogen isotopes diffuse rapidly, the deuterium passing through the thin layer and the barrier being retained by the support.

2. A neutron-emitting tritiated target comprising a metal layer selected from the group consisting of tritiated metal, metal hydride and a mixture of hydrides containing tritium, a passive support for the layer, the layer being thick enough to retard the deuterons bombarding the target, a thin intermediate barrier between the layer and the support, said barrier being a metal in which hydrogen isotopes diffuse slowly and having a thickness preventing the return of the deuterons from the support to the layer at the same time as the passage of the tritium toward the support, said barrier being a metal selected from the group consisting of gold, silver, copper, and aluminum, the support being a nonhydrogenizable metal, a target carrier holding the support at its periphery and an annular cooling water circuit for the carrier, the face of the support remote from the layer defining in part a cavity and means for producing a vacuum in the cavity to eliminate the deuterium which has traversed the support.

3. A neutron-emitting tritiated target as claimed in claim 2, the face of the support remote from the layer being cooled by a solution which forms an electrolyte or a chemical reagent and causes the deuterium to be eliminated electrochemically or by means of a chemical reaction.

4. A neutron-emitting tritiated target as claimed in claim 3, the solution is formed by an electrolyte, the support forming a first electrode and the target carrier a second electrode for electrolysis of the solution.

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