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Merges

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[54] RADIOISOTOPIC GENERATOR

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[51] **Int. Cl.** **G21h 1/10**

[58] **Field of Search** 136/202

[56] **References Cited**

UNITED STATES PATENTS

3,075,030	1/1963	Elm et al.	136/202 X
3,272,658	9/1966	Rush	136/202 X
3,347,711	10/1967	Banks, Jr. et al.	136/202
3,357,866	12/1967	Belofsky	136/202
3,401,064	9/1968	Perlow et al.	136/202
3,472,702	10/1969	Yeats et al.	136/202

OTHER PUBLICATIONS

TID-22350, Nov. 1965, pp. 18, 19, 62-65, 67-69, 71, 72, 78, 81, 86, 87.

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Attorney—McGlew & Toren

[57] **ABSTRACT**

A radioisotopic or radionuclide generator comprises a radioisotope as a heat source and sealed within a thin-walled metal cylinder. Thermoelectric energy converters are arranged in heat transfer relation with the metal cylinder, and a thermal insulation surrounds the metal cylinder and the energy converters. The heat source, the energy converters and the thermal insulation are sealed within a thick-walled metal safety capsule whose exterior surface may be provided with a coat of depleted uranium to absorb gamma rays. The thick-walled sealing capsule has a central cylindrical portion and two hemispheric end portions welded or otherwise integral with the central cylindrical portion. The hemispheric ends of the capsule are designed as heat bridges for the energy converters. The thermal insulation is in the form of a cylinder whose mid-portion comprises a plurality of thin radially spaced metal foils of high thermal reflecting power, the spaces between the metal foils being highly evacuated. The end portions of the heat insulating cylinder comprise fibrous heat-insulating material, such as quartz cotton wool.

5 Claims, 2 Drawing Figures

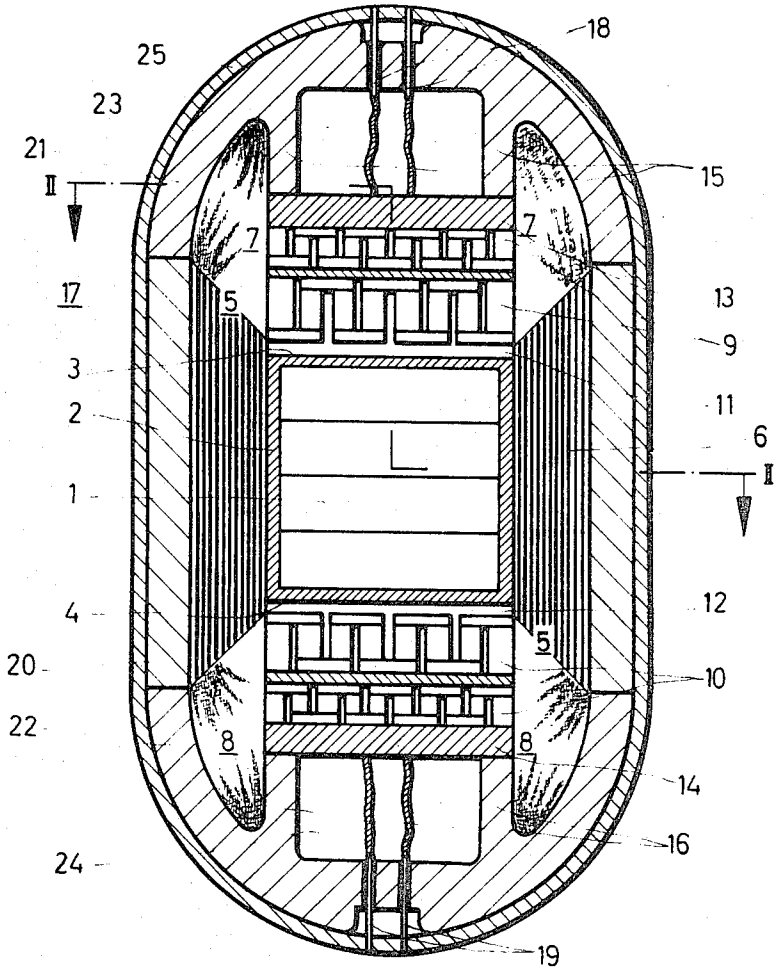


Fig. 1

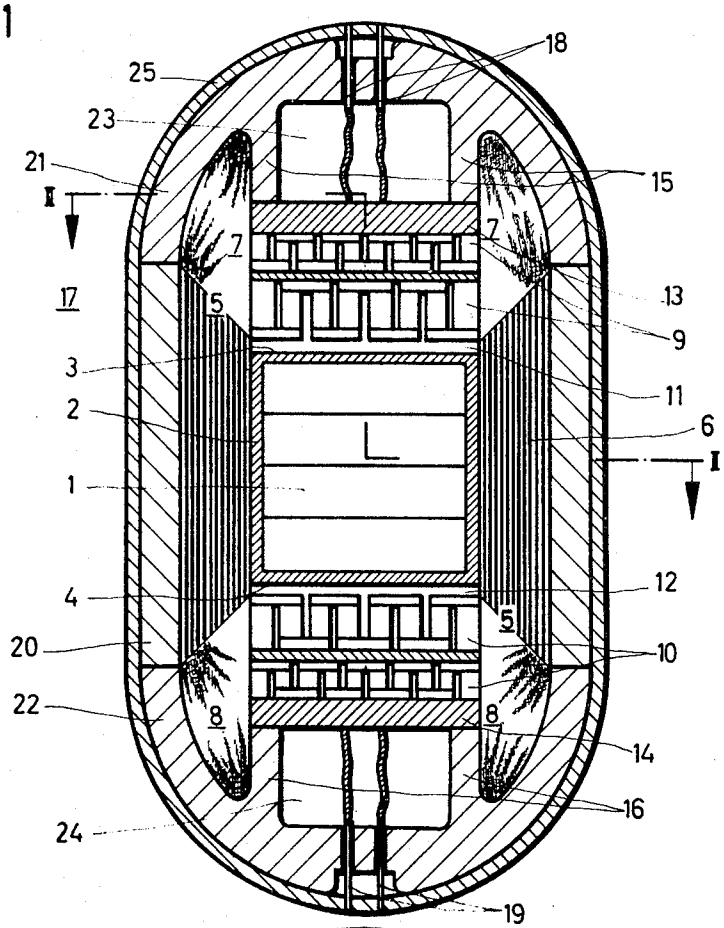
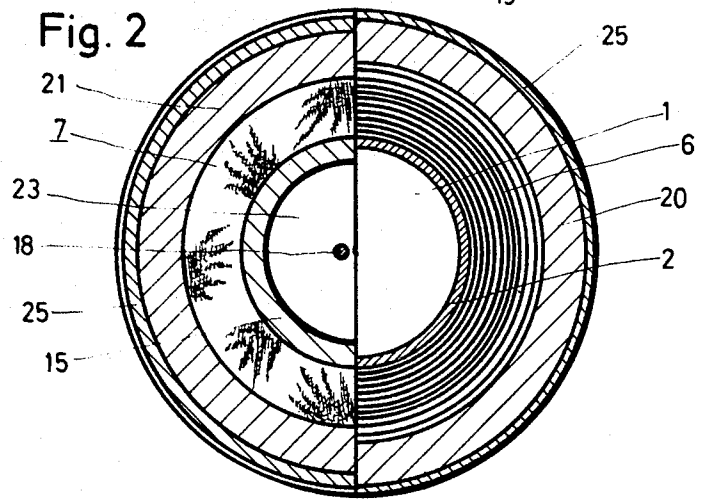


Fig. 2



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RAPIOISOTOPIC GENERATOR

BACKGROUND OF THE INVENTION

Known radioisotopic generators, particularly for the production of electric power utilizing a radioisotope as a heat source, include an enclosure for the radioisotope, thermoelectric energy converters, heat insulation, and heat collecting plates for eliminating the heat traversing the energy converters, such as shown, for example, in German Auslegeschrift 1216955. In these known radioisotopic generators, the sealing enclosure of the radioisotope is designed as a thick-walled safety tank, and the energy converters are positioned on the exterior of this safety tank.

Since radioisotopic generators work at operating temperatures of up to 2000°C, the safety tank must consist of highly refractory material, to make certain that no radioactive material is released under any circumstances.

In addition, the safety tank must be corrosion-resistant at these high temperatures over a long period, such as decades, or for as long as the enclosed radioisotope emits dangerous radiation.

Since the safety tank also must inclose the radioisotope safely against accidents, for example, falls, it must be designed, at the same time, as a pressure tank.

These three requirements regarding the stability of the capsule or radioisotope enclosure to great heat, corrosion and pressure, limit the selection of the material for the safety tank and increase, additionally, the costs of such radioisotopic generators.

Another disadvantage of known radioisotopic generators is that the enclosure for the radioisotope, which must have very thick walls because it must also function as a safety tank, increases the surface of the heat source and thus the heat losses.

With reference to the foregoing, a definition of certain terms would be helpful. Thus, according to the "Code of Safety Practice on the Design, Installation and Use of Radioisotope Power Generators," published by the International Atomic Energy Agency in June 1968, the term "capsule" denotes a device which effects the complete and tight sealing of the radioisotope and which can withstand all transportation loads, operational loads and accident loads without releasing its radioactive contents. Specifically, a "capsule" is defined as a "fuel envelope" designed to prevent any dispersion of radioactive material.

In addition, a radioisotopic generator has a so-called "generator housing" which holds together mechanically the above-mentioned so-called "hot capsule," the thermoelectric energy converter means, the heat insulation, and the like. All known isotopic generators, such as, for example, SNAP-3, SNAP-7, URIPS, SNAP-21, SNAP-23, MARGUERIT, and RIPPLE, are built in accordance with the concept outlined above.

SUMMARY OF THE INVENTION

This invention relates to radioisotopic generators, particularly for the production of electric power, and, more particularly, to an improved and simplified radioisotopic generator in which the capsule necessary for safely enclosing the radioisotope contains, in addition to the radioisotope. the energy converters and the thermal insulation.

The objective of the invention, based on known radioisotopic generators, is to provide a radioisotopic

generator which also meets the usual safety requirements regarding the enclosure of the radioisotope, but which is not subject to the restrictions, with respect to the selection of the material for the safety tank, and where the heat source is small. In accordance with the invention, this problem is solved in that the capsule, required for the safe enclosure of a radioisotope, contains, in addition to the radioisotope, the energy converters and the thermal insulation.

In accordance with the preferred embodiment of the invention, the metal cylinder surrounding the radioisotope is thin-walled, and it has two end faces which are operatively associated, or in heat transfer relation, with the hot sides of the thermoelectric energy converters which are surrounded, together with the metal cylinder, by a concentric thick-walled heat insulating cylinder. This heat insulating cylinder is open at both ends, and the end zones are associated with heat bridges which are parts of a thick-walled safety capsule. The safety capsule is sealed all around and surrounds the entire arrangement, and has extending therethrough only the insulated electric conductors. These heat bridges hold the energy converters, positioned adjacent opposite ends of thr radioisotope, through the medium of heat collecting plates which are in good thermal contact with the cold sides of the energy converters.

Such a design has many advantages. Thus, the entire surface of the safety capsule can be cooled directly from all directions, so that it is heated only slightly above the ambient temperature, independent of the state of the energy converters. For this reason, it is possible to use materials, for the construction of the thick-wall safety tank, which need not meet as high requirements as hitherto considered necessary with respect to heat resistance and corrosion resistance at high temperatures.

Another advantage is that the safety capsule at the same time protects, in this type of radioisotopic generator, the thermoelectric energy converters against external influences such as pressure or shock. It is thus no longer necessary, when using the radioisotopic generators at great depths in the sea, to surround the generators with pressure resistant shells.

Since the cylinder sealingly enclosing the radioisotope does not have to meet the above-mentioned safety requirements, it can have very thin walls. The surface of the heat source is thus considerably smaller than in known radioisotopic generators utilizing the same quantity of radioisotope as a fuel.

In accordance with a further feature of the invention, the capsule enclosing the radioisotope, the energy converters and the thermal insulation is highly evacuated, so that the danger of corrosion for all metal parts within the safety capsule is thus even further reduced, including reduction of the danger of corrosion of the inner wall of the safety capsule.

In a preferred embodiment of the invention, the safety capsule consists of a tubular or cylindrical center piece with two welded-on hemispherical heads or caps. The tubular center piece and the caps are so designed that they enclose the heat insulating cylinder.

As a heat insulating material, there are provided several layers of thin metal foils, of high thermal reflecting power, whose interspaces are highly evacuated. However, it is also possible to use fibrous heat-insulating material, for example, glass wool.

As a further feature of the invention, the heat bridges are designed as hollow cylinders so as to define cavities within the safety capsule. Within these cavities there can be arranged, if necessary, consumers of the electric energy supplied by the radioisotopic generator, or other auxiliary devices.

Within the scope of the invention, either the capsule per se or together with an additional coat on its inner or outer surface, for example, may be provided with an additional coat of depleted uranium for the absorption of gamma rays, this coating being designed as a screen against the radiation of the radioisotope. Furthermore, in place of thermoelectric energy converters, it is also possible to use thermoionic converters.

An object of the invention is to provide an improved radioisotopic generator particularly for the production of electric power using a radioisotope as a heat source.

Another object of the invention is to provide such a radioisotopic generator which meets the usual safety requirements with respect to enclosure of the radioisotope but which is not subjected to the usual restrictions with respect to the selection of the material for the safety tank.

A further object of the invention is to provide such a radioisotopic generator in which the capsule, required for sealing of a radioisotope, contains, in addition to the radioisotope, the energy converters and the thermal insulation.

Another object of the invention is to provide such a radioisotopic generator in which the radioisotope is sealed within a thin-walled metal cylinder having end faces in heat transfer relation with the hot sides of thermoelectric energy converters.

A further object of the invention is to provide such a radioisotopic generator in which the enclosure of the radioisotope and the energy converters are surrounded by a concentric thick-walled heat insulating cylinder open at both ends.

Another object of the invention is to provide such a radioisotopic generator including heat bridges associated with the ends of the heat insulating cylinder and forming parts of a thick-walled safety capsule sealed on all sides and surrounding the entire arrangement.

For an understanding of the principles of the invention, reference is made to the following description of a typical embodiment thereof as illustrated in the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing:

FIG. 1 is a longitudinal or axial sectional view through a radioisotopic generator embodying the invention; without the generator housing and

FIG. 2 is a section along the line II-II of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the radioisotopic generator illustrated in FIGS. 1 and 2, four disks 1, of a radioisotope, are stacked to form a cylinder which is surrounded by a thin-walled metal cylinder 2 having end faces 3 and 4. A thick heat-insulating cylinder 5, open at both ends, surrounds metal cylinder 2 and is arranged coaxially with the latter. The edge end zones 7 and 8 of heat-insulating cylinder 5 extend beyond end faces 3 and 4 of metal cylinder 2.

The central portion of heat-insulating cylinder 5 consists of numerous thin metal foils of high thermal reflecting power, and the space between adjacent metal foils is highly evacuated. In its two edge zones 7 and 8, cylinder 5 consists of fibrous heat-insulating material such as, for example, quartz wool.

The end zones 7 and 8 of heat-insulating cylinder 5 adjacent the respective end faces 3 and 4 of metal cylinder 2 define cavities in which there are positioned respective thermoelectric energy converters 9 and 10 connected in cascade. The hot sides of these converters face the respective end faces 3 and 4 of metal cylinder 2. However, between the end faces 3 and 4 and the hot sides of the respective thermoelectric energy converters 9 and 10 there are left expansion gaps 11 and 12 which can be filled with a material of good thermal conductivity but which is elastic by virtue of its geometric form. For example, this could be a fibrous blend or a wool of highly refractory material, or an electrical insulating material of good thermal conductivity.

Thermoelectric energy converters 9 and 10 are held in position by circular heat collecting plates 13 and 14, respectively, which are in good thermal and electrically insulated contact with the cold sides of the energy converters 9 and 10. To this end, the heat-collecting plates 13 and 14, whose diameter is equal to the internal diameter of heat-insulating cylinder 5 which secures them against lateral displacement, cooperate with metal heat bridges 15 and 16 which form fixed parts of a thick-walled safety capsule 17.

Safety capsule 17 encloses the entire arrangement, and has extending therethrough, in sealed relation, only the insulated electric conductors 18 and 19 for the thermoelectric converts. This safety capsule consists of a tubular or cylindrical center piece 20 and two welded-on hemispherical caps or heads 21 and 22. The inside diameter of center piece 17 is equal to the outside diameter of heat-insulating cylinder 5, so that the latter is firmly positioned by safety capsule 17. Cavities 23 and 24, defined by heat bridges 15 and 16, are in the shape of hollow cylinders and serve furthermore to receive consumers of electric energy supplied by the radioisotopic generator, and which are not shown, or to receive other auxiliary devices.

Safety capsule 17 is covered by an additional coat 25 of depleted uranium for the absorption of gamma rays. Naturally, the surface of capsule 17 can be increased by convection plates and, instead of the represented capsule form, it is also possible to use a different capsule form, for example, a sphere.

While a specific embodiment of the invention has been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. A radioisotope capsule, forming a sealed safety enclosure for a radioisotope and capable of withstanding all transportation, operational and accident shocks without release of its radioactive content, said capsule comprising, in combination, a thin-walled metal cylinder forming a sealed enclosure for a radioisotope encased therein; two thermoelectric converters each having a hot side in heat transfer relation with a respective end wall of said metal cylinder; a thick-walled heat insulating cylinder, open at both ends, laterally surrounding and containing said thin-walled metal cylinder and

said thermoelectric converter, and substantially coaxial with said thin-walled metal cylinder; a thick-walled metal safety capsule laterally embracing and contacting said heat-insulating cylinder and having closed ends, said metal safety capsule forming a completely sealed enclosure encasing said thin-walled metal cylinder, said thermoelectric converter and said thick-walled heat-insulated cylinder; insulated conductors for said thermoelectric converter extending in sealed relation through said metal safety capsule, said thick-walled heat-insulating cylinder having end zones extending beyond said thermoelectric converters; respective heat bridges operatively associated with said end zones and forming part of said metal safety capsule; and respective heat-collecting plates in good thermal contact with the cold sides of said thermoelectric converters; said heat bridges engaging said heat-collecting plates to retain said thermoelectric converters in position; said safety capsule being highly evacuated and consisting of a tubular central cylinder surrounding said heat-insulating cylinder and two hemispherical caps welded to said central cylinder and having said heat bridges extending inwardly therefrom; said heat bridges being in the form of hollow cylinders defining cavities within said safety capsule.

2. A radioisotope capsule, as claimed in claim **1**, in which said heat-insulating cylinder consists of a plurality of layers of thin metal foils of high thermal reflecting power.

3. A radioisotope capsule, as claimed in claim **1**, in which said heat-insulating cylinder consists of a fibrous heat-insulating material.

4. A radioisotope capsule, as claimed in claim **1**, in which said fibrous heat-insulating material comprises quartz wool.

5. A radioisotope capsule, as claimed in claim **1**, including a coat of depleted uranium on the exterior surface of said safety capsule, for absorbing gamma rays.

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