

[54] **HEAT TRANSFER SYSTEM FOR RADIOISOTOPE GENERATORS**

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[73] Assignee: **The United States of America as represented by the Secretary of the Navy**

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[51] Int. Cl.**F28f 13/00**

[58] Field of Search.....165/47, 80, 185; 310/3 R; 136/202; 250/106 R, 108 R

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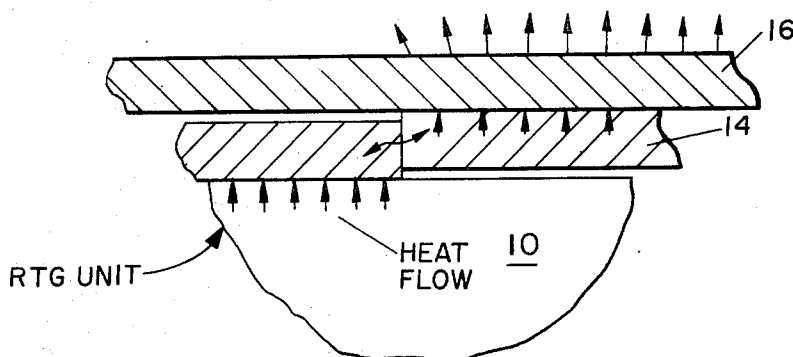
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[57] **ABSTRACT**

A device to dissipate heat from a radioisotope generator mounted in a separate housing which is designed to protect the generator from excessive water pressure. The device includes a pair of split elongate heat transfer cylinders positioned around the generator within the housing. One of the cylinders is in a contiguous relationship with the generator while the other cylinder is contiguous only to the housing. Both cylinders are in an end abutting relationship so as to provide a path for the flow of heat to the housing.

3 Claims, 5 Drawing Figures



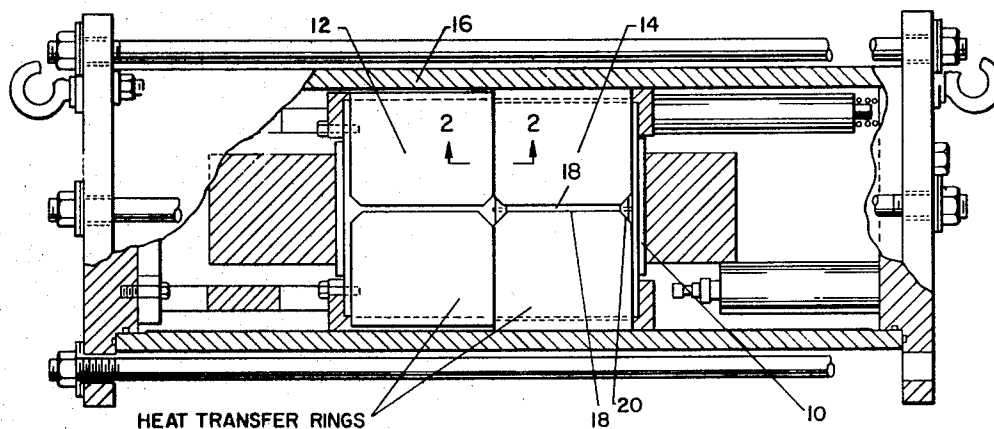


FIG. 1

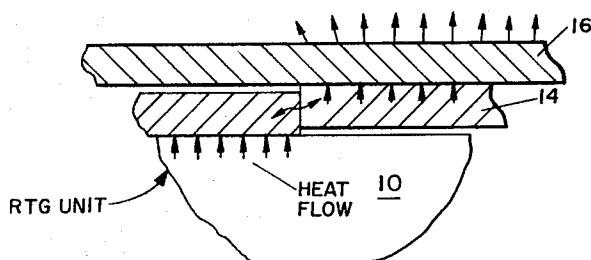


FIG. 2

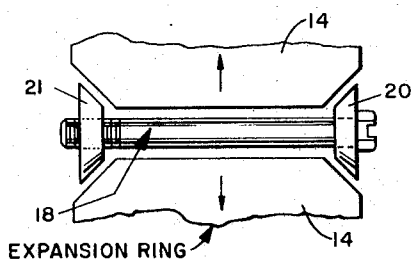


FIG. 3

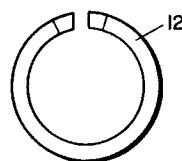


FIG. 4

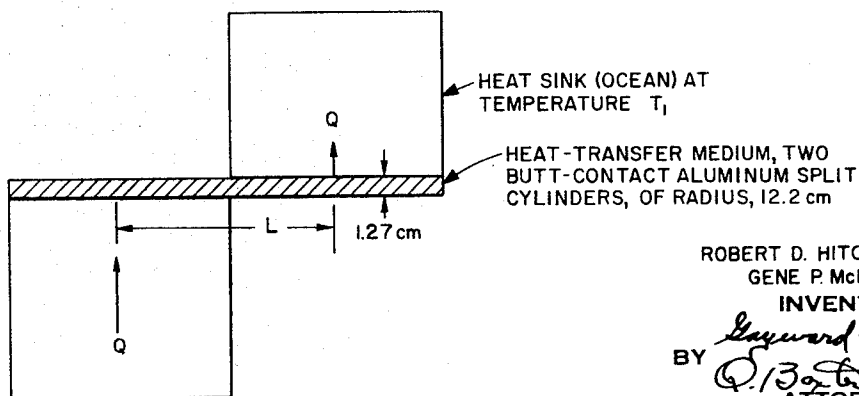


FIG. 5

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HEAT TRANSFER SYSTEM FOR RADIOISOTOPE GENERATORS

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

1. Field of the Invention.

This invention relates to devices for dissipating heat from a heat generating source such as a submerged radioisotope generator. More particularly the invention relates to devices for removing waste heat from such generators which are enclosed in a protective housing and in an underwater environment.

2. Description of the Prior Art.

Radioisotope power devices utilize the heat generated by radioactive material to produce electricity. However, all thermoelectric devices must conduct waste heat to the surrounding area at a rate high enough to keep the temperature of such devices below a specified limit. Otherwise the heat will not be rejected fast enough to maintain a necessary temperature difference between the hot and cold sides of the thermoelectric device. This condition results in insufficient power output.

When the radioisotope power device is enclosed in a separate housing, the problem of heat dissipation is even more critical unless the walls of the housing are in direct contact with the outside surface of the device.

In many prior structures the contact between a power device or generator and the housing is accomplished by the employment of small copper spheres in the annular space between the porous device and the housing. An inherent disadvantage of such a method to remove waste heat is that the small spheres often become lodged in the O-ring grooves which may cause a seal leak in the event the power device is used in an aqueous environment. Another disadvantage is the tediousness involved in packing the copper spheres; also internal electrical connections must be protected from them.

SUMMARY OF THE INVENTION

Briefly the present invention involves a device to remove waste heat from a radioisotope generator enclosed in a protective housing. It includes a pair of split elongate heat transfer cylinders, one of which is in a contiguous relationship with the generator while the other is contiguous to the housing. Both cylinders are in an abutting relationship to provide for the flow of heat from one cylinder to the other and then to the housing and thence to the exterior heat sink.

STATEMENT OF THE OBJECTS OF THE INVENTION

Accordingly it is an object of the present invention to provide an inexpensive device to dissipate waste heat from a radioisotope generator enclosed in a separate housing.

Another object of the present invention is to provide a reliable means of transferring waste heat from a radioisotope generator into an oceanographic housing which is in direct contact with water.

Other objects, advantages and novel features of the invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic drawing partially cut away showing the heat transfer cylinder in position within a protective housing.

FIG. 2 is an enlarged section along the line 2—2 of FIG. 1.

FIG. 3 is an enlarged view showing the detail of the expansion wedge and screw.

FIG. 4 is an end view of one of the heat transfer cylinders showing the split therein.

FIG. 5 is a schematic representation of the heat transfer process evolving from operation of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Most radioisotope generators are designed for operation in the open air since they will dissipate heat at a sufficient rate as long as the outer surface of the generator is in contact with room-temperature air. However, in the event the generator is enclosed in a protective housing, waste heat cannot be dissipated fast enough and accordingly the electrical power output is too low. Such a housing might be employed for a multitude of purposes including the protection of the generator from excessive water pressure in the event the generator is placed in a deep ocean environment.

Referring now to the drawing, the invention includes a first transversely split cylinder 12 which encompasses the generator 10 and is contiguous therewith. A second transversely split cylinder 14 is also positioned around the generator but contiguous with the inside surface of housing 16 and in butting relationship with one end of the first cylinder 12 as shown in FIGS. 1 and 2.

In placing cylinder 12 in position, it is first expanded slightly by use of a wedge assembly 18 (FIG. 3) including opposed tapered shoulders 20—21. After emplacement over one portion of the generator 10 the wedge assembly 18 is released and removed and through its own elasticity the cylinder 12 contracts to fit firmly onto the exterior surface of the generator 10.

The generator 10 and its tightly fitting contiguous cylinder 12 are then inserted into a water tight housing 16. Thereafter, the second cylinder 14 is positioned in place about the generator 10 and within the housing 16 with its inner end abutting one end of cylinder 12. The wedge assembly 18 is then actuated to expand split ring 14 into close contact with the inside wall of housing 16. The wedge assembly 18 employed in the expansion process remains in the tightened position to ensure that cylinder 14 remains firmly in contact with the inside wall of housing 16.

It is pointed out that both cylinders 12 and 14 are each preferably constructed of aluminum due to the ease in which this metal conducts heat. However, other suitable substances may be used as required.

A theoretical analysis of the operation of the invention is illustrated by the schematic shown in FIG. 5. In calculating the temperature difference existing between the radioisotope generator 10 and the heat

sink, which could be the ocean if the generator were positioned on the ocean floor, and into which the thermal energy is conducted at the same rate it is produced at the surface of the generator 10, the following equation may be used:

$$T_2 - T_1 = QL/KA$$

where $Q = 30$ joules/sec.

$$L = 17 \text{ cm}$$

$$K = 0.5 \text{ calorie. cm/sec. cm}^2 \cdot \text{c}^\circ \text{ (thermal conductivity of aluminum)}$$

$$A = (2\pi) (12.2) (1.27) = 97.3 \text{ cm}^2$$

therefore:

$$T_2 - T_1 = 2.5^\circ \text{ C}$$

This figure indicates that the outside temperature of the generator 10 need be only 2.5° C above the heat sink temperature to reject heat at the required rate of 30 joules/sec. Accordingly if the heat sink were ocean water at a depth of 6,000 feet where such radioisotope generator is expected to be positioned, the temperature is about 2° C , the generator surface will be maintained well below a satisfactory room temperature.

A modification of the invention is to vary the configuration of thermal contact between two split cylinders 12 and 14. Another modification would be to use a third unit between the first and second split cylinders 12 and 14 respectively. However, both of these modifications would require tapering the split cylinders at their contacting surfaces which makes assembly difficult and may cause damage to the housing 16.

Obviously many modifications and variations of the present invention are possible in the light of the above

teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

We claim:

1. A device to dissipate heat from a radioisotope generator which is enclosed in a separate protective housing comprising:

a first elongate heat transfer cylinder positioned around said generator and contiguous thereto, and a second elongate heat transfer cylinder also enclosing said generator but contiguous to the housing, said first and second cylinders both being in an abutting relationship along the contiguous end wall portions, said heat transfer cylinders adapted to satisfactorily conduct heat to the exterior heat sink when the generator temperature is not less than 2.5° C above the heat sink temperature.

2. The heat dissipation device as defined in claim 1 wherein

both the first and second heat transfer cylinders are transversely split to ensure firm contact with the generator and the housing.

3. A device to dissipate heat from a heat generator enclosed in a protective housing as defined in claim 1 wherein:

a wedge assembly is positioned adjacent said second cylinder to maintain the expanded condition of said cylinder and insure contact thereof with the housing.

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