United States Patent

Bilinski et al.

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[54] **THERMAL SHIELD**

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[52] **U.S. Cl.** **165/32,** 74/5, 165/47, 165/105, 219/201, 219/385, 219/530

[51] **Int. Cl.** **F28d 15/00**

[58] **Field of Search** 165/105, 32, 47; 219/365, 378, 219/385, 201, 530; 74/5

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[57] **ABSTRACT**

A thermal shield consisting of a pair of walls forming an enclosed space. A heat exchange fluid is disposed in the space between the walls and is maintained at a working temperature whereby it changes in phase in response to changes in temperature along one of the walls.

2 Claims, 4 Drawing Figures

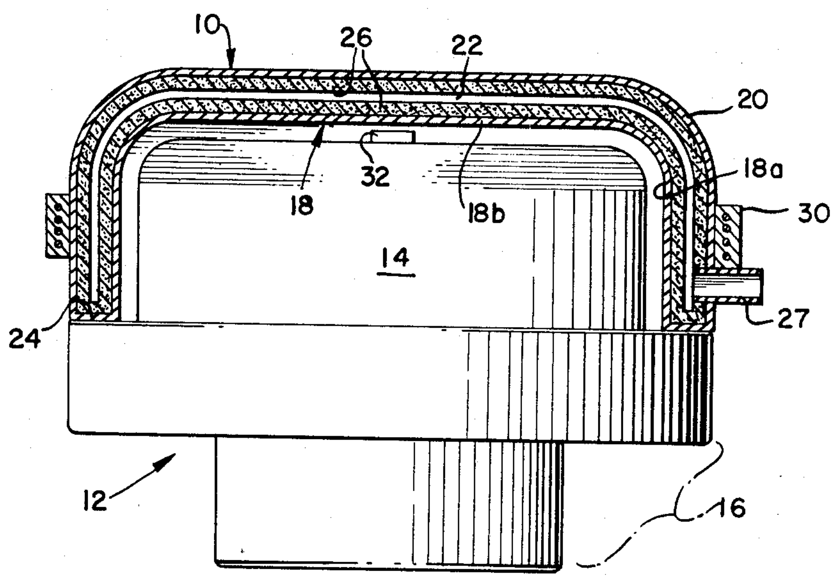

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FIG. 1.

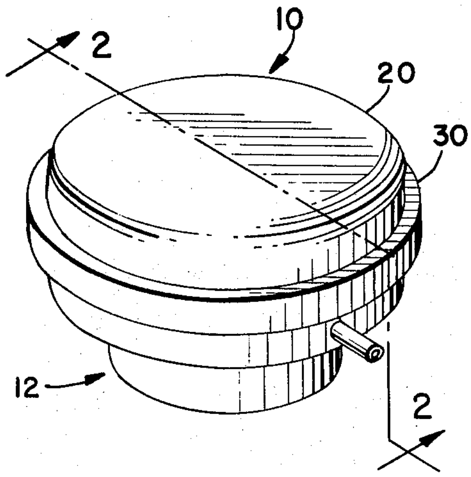


FIG. 3.

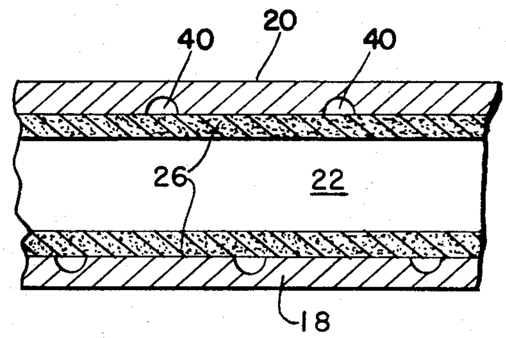


FIG. 4.

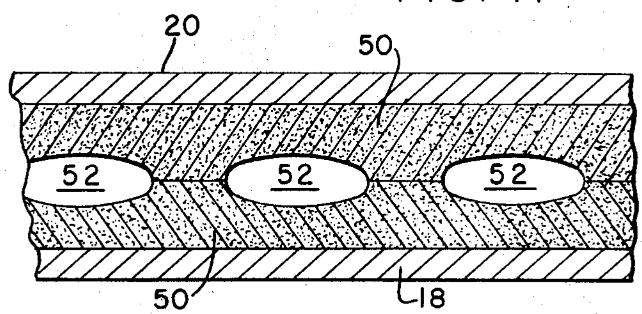
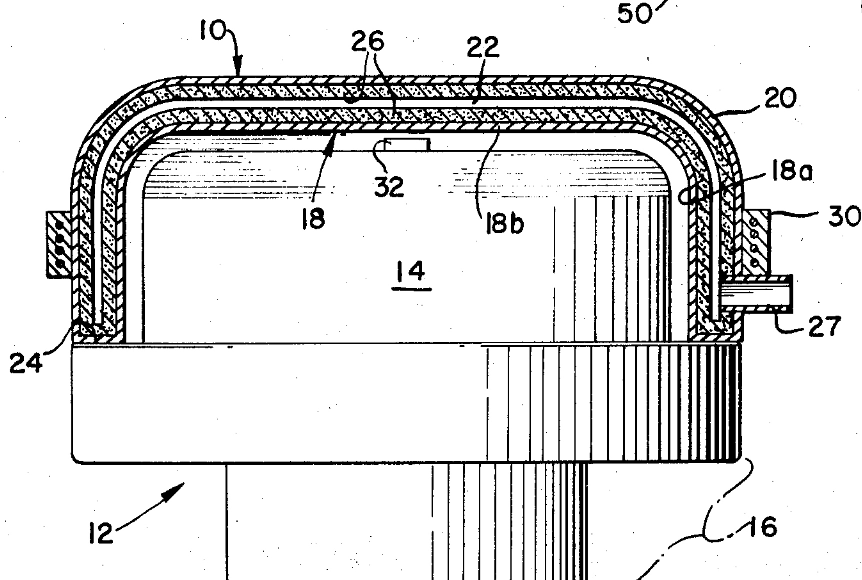


FIG. 2.



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THERMAL SHIELD

BACKGROUND OF THE INVENTION

This invention relates to a shield, and more particularly to a thermal shield for shielding and isolating an external device.

Thermal shields have been proposed which utilize solid structure adapted to absorb heat and remove it to cooler regions. Other designs utilize non-conductive vacuum chambers to isolate inner regions from sensitivity to the external environmental conditions. However, both of these techniques have shortcomings due to the temperature gradients resulting from thermal resistance and power required for cooling flow. Also, complete isolation by vacuum installation is frequently impossible due to the need for structural integrity, demanding mounting contact support at the unit.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a thermal shield which significantly reduces temperature gradients by absorbing and transferring large variations in heat loads.

Toward the fulfillment of these objects, the thermal shield of the present invention comprises a pair of spaced walls forming an enclosure, a heat exchange fluid disposed in said enclosure, means to establish a working temperature for said fluid whereby it changes in phase between a liquid and a vapor in response to changes in temperature occurring at the outer surface of one of said walls, and means to effect the transfer of said liquid along the inner surfaces of at least one of said walls by capillary action.

BRIEF DESCRIPTION OF THE DRAWINGS

Reference is now made to the accompanying drawings for a better understanding of the nature and objects of the present invention. The drawings illustrate the best mode presently contemplated for carrying out the objects of the invention and are not to be construed as restrictions or limitations on its scope. In the drawings:

FIG. 1 is a perspective view of the thermal shield of the present invention, utilized as a cover for a gyroscope;

FIG. 2 is an enlarged sectional view taken along the line 2—2 of FIG. 1;

FIG. 3 is an enlarged partial view of a structure similar to FIG. 2 but depicting another embodiment of the present invention; and

FIG. 4 is a view similar to FIG. 3 but depicting still another embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the embodiment of FIGS. **1** and **2**, the reference numeral **10** refers to the thermal shield of the present invention which for the purposes of example, is depicted in the form of a generally dome-shaped cover extending over a gyroscope **12**. The gyroscope includes an upper housing **14** and a lower housing **16**, and since this and the remaining structure of the gyroscope is conventional, it will not be described in any further detail.

The shield **10** is formed by an inner wall **18** having a cylindrical portion **18***a* which extends vertically as viewed in FIG. **2**, and a substantially hemispherical portion **18***b* closing the top of the cylindrical portion. It is noted that the inner wall **18** is of a similar shape as the upper housing **14** of the gyroscope and, in certain applications can actually form the upper housing.

An outer wall **20** extends over the inner wall **18** in a spaced relation thereto to form a chamber **22**. The lower ends of the walls **18** and **20** are bridged by an annular end wall **24** which rests on the upper portion of the lower housing **16** of the gyroscope.

A matrix of porous material, shown in general by the reference numeral **26**, is secured to the inner surfaces of the walls **18**, **20**, and **24**. In this manner, a "heat pipe" is formed, whereby a working fluid, such as water, introduced into the chamber **22** by means of a tube **27**, and maintained at a predetermined working temperature, undergoes a change in phase in response to temperature changes occurring in proximity to the outer wall **20**. As a result, the temperature along the inner wall is maintained substantially constant in accordance with classic heat pipe theory.

In order to regulate the working temperature of the fluid within the cover **10**, a heater **30** extends around the outer circumference of the cylindrical portion of the wall **20**. The heater may take any conventional form, such as an electric resistance wire housed in a casing as shown. A sensing device, shown diagrammatically by the reference numeral **32**, is mounted on the upper housing **14** of the gyroscope, and is adapted to control the operation of the heater **30** in accordance with variations in temperature occurring in the vicinity of the gyroscope **12**. To achieve this, the sensing device may be connected in a servo loop with the heater in a conventional manner.

In operation, a predetermined working temperature for the fluid is established by means of the heater **30** and this temperature level is maintained uniform within a limited range by virtue of the saturation properties of the liquid and vapor within the cover **10**, despite variations in temperature along the outer wall **20**. In particular, temperature fluctuations along the outer surface of the wall **20** in response to ambient temperature changes, for example, causes the latent heat of vaporization of the fluid to be absorbed or released accordingly. Thus, upon an external cooling condition occurring on the outer surface of the wall **20**, the vapors within the tube condense at the cool zone and release their heat of formation. The condensed fluid passes into the material **26** and moves by capillary action to a warmer position along the inner surface of the wall **20**. If a rise in temperature occurs anywhere along the outer surface of the wall **20**, the opposite condition occurs, to wit, a portion of the liquid in the material **26** in the vicinity of the hot zone is vaporized and the vapor, due to its resultant increased pressure, moves to a lower pressure zone whereby it condenses and gives up its heat energy. Due to the fact that the above changes of phase of the fluid occurs at substantially the same temperature, the temperature along the cover, including the inner wall **18**, is maintained constant. The shield **10** thus provides a practical and realistic means of significantly reducing temperature gradiants while absorbing and transferring large variances in heat loads.

Since the embodiment of FIG. **3** is similar to that of FIGS. **1** and **2**, only a portion of the shield will be shown in FIG. **3**, and identical structure will be given the same reference numerals. According to this embodiment, the inner wall **18** and the outer wall **20** are each provided with a plurality of arterial grooves **40** which are covered by the matrix of porous material **26**. These grooves provide low resistance arteries for liquid flow along the cover in the above-mentioned heat transfer process, and thus may increase the efficiency of the process.

In the embodiment of FIG. **4**, a matrix of porous material **50** is disposed along each of the inner surfaces of the walls **18** and **20**, and is of a thickness sufficient to fill the entire space between the walls. A plurality of channels **52** are provided at the interface of the material disposed along each of the walls. The material **50** thus provides an increased surface area for capillary flow of the working fluid in a liquid state, while the channels **52** permit flow of the fluid in a vapor state.

Many other variations may be made in the above without departing from the scope of the invention. For example, the grooves **40** and the channels **52** may extend in a direction or directions other than that shown in the drawings. Also, the matrix of porous material can be formed by sintering powdered metals to their respective inner wall surfaces. Of course, still other variations of the specific construction and arrangement of the shield disclosed above can be made by those skilled in the art without departing from the invention as defined in the appended claims.

We claim:

1. A thermal shield comprising a pair of spaced walls forming an enclosure, a heat exchange fluid disposed in said enclosure, a heater disposed on one of said walls, means for controlling the operation of said heater to establish a substantially constant working temperature for said fluid whereby it changes in phase between a liquid and a vapor in response to changes in temperature occurring at the outer surface of said one of said walls, a matrix of porous material disposed on the inner surface of each of said walls for permitting the transfer of said liquid along the inner surface of said walls by capillary action, and a plurality of grooves formed on the inner surfaces of said walls and enclosed by said matrix of porous material to decrease the resistance to said transfer of liquid.

2. The shield of claim 1 wherein said walls together form a cover having a substantially cylindrical portion and a substantially hemispherical portion extending over the top of said cylindrical portion, said one wall forming the outer wall of said cover, and said other wall forming an inner wall of said cover.

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