United States Patent

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[54] LIFE SUPPORT SYSTEM FOR DEEP SUBMERSIBLE VEHICLES

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[52] **U.S. Cl.** .....**114/16 R,** 62/435, 114/0.5 R, 244/1 SC

[51] **Int. Cl.** **B63g 8/00**

[58] **Field of Search** .....114/16 R, 0.5 R; 61/69 R; 62/434, 435, 436, 438, 6; 244/1 SC

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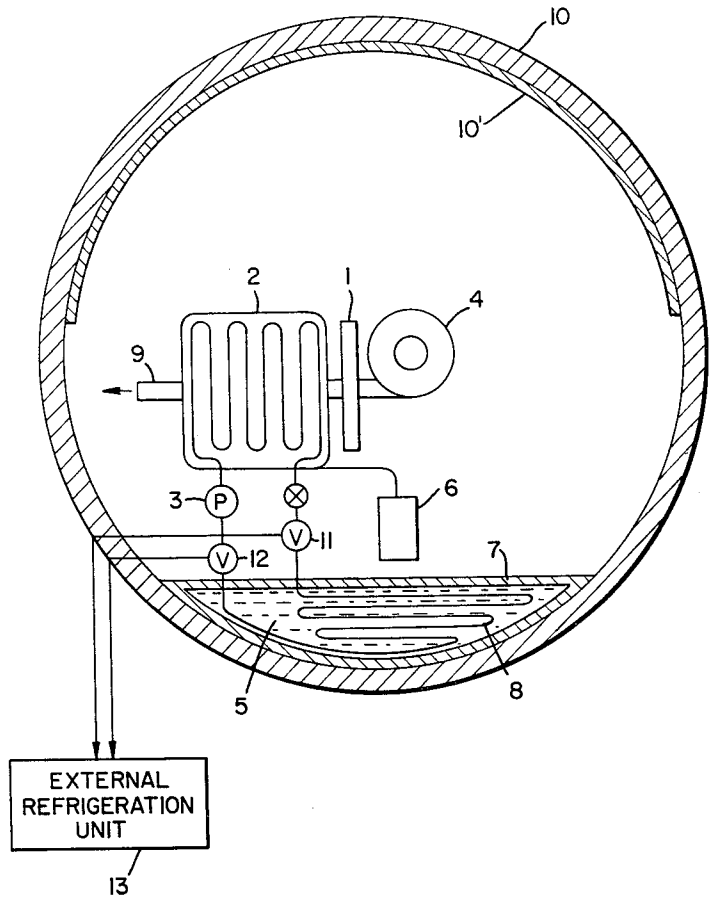
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[57] **ABSTRACT**

A cooling system for a deep submersible vehicle having a cabin and a false floor. The cooling medium of the cooling system has a high specific heat and is stored in the normally unused space beneath the false floor. The cooling media is super-cooled or frozen by the refrigeration system of a mother ship. One heat exchanger is located in the cooling medium and another heat exchanger is located in the crew department of the cabin. A circulation system is provided between the two heat exchangers. Heat for the vehicle is provided by the vehicle passengers, electric equipment, a CO_2 scrubber and a heater if required.

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.

7 Claims, 2 Drawing Figures



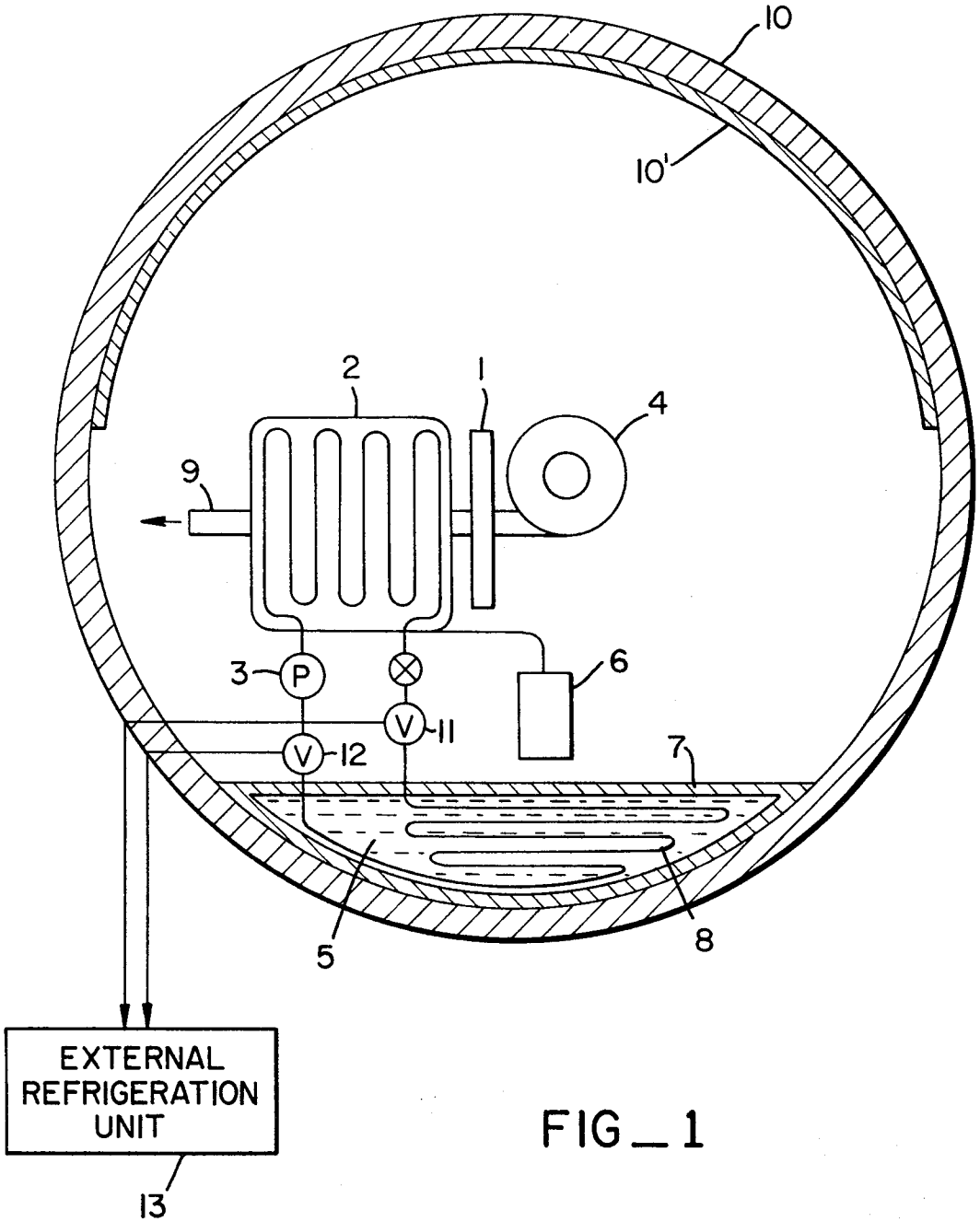


FIG_1

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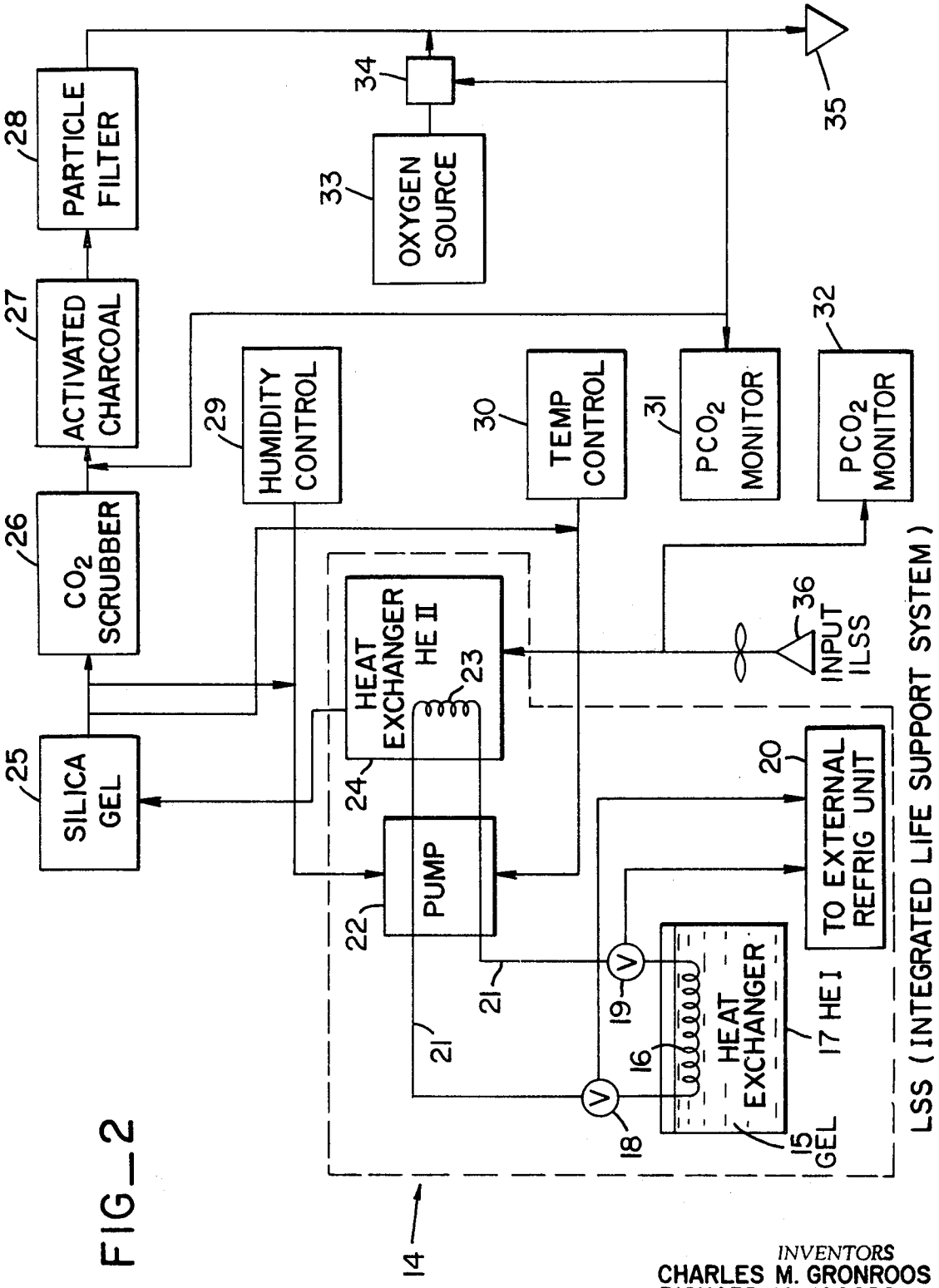


FIG_2

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LIFE SUPPORT SYSTEM FOR DEEP SUBMERSIBLE VEHICLES

BACKGROUND OF THE INVENTION

This invention relates generally to a simple cooling component of a life support system of a deep submersible vehicle where cooling systems are required, and more particularly to a temperature control comprising a self-contained heat exchanger system having low power requirements.

In previous cooling systems, power was required for both heating and cooling or no heating or cooling capabilities existed at all. If the prior systems did use heating and cooling systems, it was accomplished by self-contained refrigeration units, thermoelectric systems and/or various heat exchanger systems with one heat exchanger located inside the sphere against the hull and the second heat exchanger located externally from the hull. All of the previous systems used pumps to circulate the cooling media (water or water-glycol) through the heat exchangers. Some of the systems required compressors and additional pumps for normal operation. If the unit was capable of cooling only, then a separate unit was usually added to heat the system. Power for the free swimming submersible unit described above required high voltage batteries and extra cells to sustain operation. This previous system added weight and required more space. An increase in weight increases the requirement for more buoyant material to support this weight, which could increase the overall size and weight of the vehicle or reduce its payload.

SUMMARY OF THE INVENTION

The major advantage of the cooling system of the present invention over the prior systems is the low power requirement needed to cool the cabin; that is, only a cooling system is needed to cool.

The heat needed for normal crew comfort is generated by the three men, electronic equipment and a CO_2 scrubber. If additional heat is desired, an auxiliary heater may be used as a supplementary source. However, if the sphere were properly insulated the supplementary source would not be required. The unique system occupies the unusable space in the bottom of the sphere beneath the floor unlike comparable equipment which occupies much needed space in the crew compartment.

STATEMENTS OF THE OBJECTS OF THE INVENTION

A particular object of the invention is to provide a system to both heat and cool and support three men for 12 hours with a safety factor of 300 percent.

Another object of the invention is to provide a heating and cooling system that is small, efficient and reliable.

Another object of the invention is to provide a cooling device in a passive life support system that requires low power and performs within the full range of its design.

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:

FIG. **1** is a drawing showing the sphere and the integrated temperature control (heat sink) combination; and

FIG. **2** is a diagram of the basic life support system including an illustration of the inventive heat exchanger system.

A particular feature of the inventive system is the large heat sink or heat exchanger. This device is located beneath the false floor of the cabin and consists of a container filled with water or some other substance with a high specific heat. The unit functions by pumping a heat exchanger fluid through the cabin heat exchanger wherein the air is cooled and excess humidity is removed. Referring to FIG. **1**, specifically, the heat exchanger HE I unit **7** is cooled by a contained volume of gel **5** which freezes at least −10° F and has a specific heat equal to that of water. The gel **5** is located under the floor **7** in the bilge, in a well insulated container, with refrigeration coils **8** running through the composite unit. The heat exchanger system is connected to an external refrigeration unit **13**

through valves **11** and **12**. When V–**11** and V–**12** are closed the heat exchanger HE I **7** is connected to heat exchanger HE II **2** and dehumidifier **6**. Note V–**11** and V–**12** could be disconnecting couplings which could be used to connect unit **7** and unit **2** or unit **7** and **13**, thus isolating the odd unit in either case. The coolant pump **3** used to circulate a water-glycol solution is connected between the two heat exchangers. A condensate collector **6** is connected to the heat exchanger HE II **2**. A blower **4**, air filter **1** and a ventilation air outlet are part of the overall life sustaining system. The sphere **10** is insulated in the upper cabin area with a wall insulation material **10'**. Referring to FIG. **2**, before a dive, a dockside refrigeration unit or an external unit **20** is connected to the refrigerator coils **18** and **19** and the gel **15** is cooled to about −30° F. The coils **16** are purged of freon, then connected to the cabin heat exchanger HE II **23** and the whole system filled with a water-glycol solution. A variable speed pump **22** will circulate the coolant through the "ice block" coils and the cabin heat exchanger during the dive. This system is very simple and can cool the cabin even in warm water. The system eliminates the need for using toxic material directly in the cooling system.

Referring to the diagram in FIG. **2** wherein the heat exchanger for the Integrated Life Support System (ILSS) for deep submersible vehicles functions in the following manner: a thermally insulated container, heat exchanger HE I **17** containing a material of high specific heat such as water, light salt brine, blue-ice gel or any material which has a specific heat equal to that of water, is super cooled to a temperature below the materials freezing point. For example, the blue-ice gel freezes at about −10° F. Immersed within the container (heat exchanger HE I **17** and the gel **15** is a continuous copper or aluminum refrigeration tube or coil **16**. This tube contains a fluid capable of removing heat energy from HE II heat exchanger **24**, located in the cabin. The fluid can be either a water glycol solution or any other non-toxic fluid with a low freezing point. Since the atmosphere within the submersible vehicle must be kept free from any toxic substance, great care must be exercised if the freon is used as a substance to initially cool the "ice block." The Alternative is to use a non-toxic media such as a brine or water-glycol solution for this heat removal process.

OPERATIONAL CHARACTERISTICS

The heat exchange system, hereafter referred to as HE I and HE II, functions as follows: Prior to the dive the HE I heat exchanger **17** system is by-passed from ILSS. An external or shipboard refrigeration unit is then connected to the refrigeration coils **18** and **19** of HE I **17** and is operated until the temperature has been lowered to a predetermined temperature below freezing, or, about −30° F for the gel **15**. Upon completion of this refrigeration process the external freezer **20** is disconnected. The refrigeration coils are purged of freon and the normal coolant material is replaced. Finally the coils **16** are reconnected to the heat exchanger. Once the vehicle has been placed in the water the following situations could arise: Warm water will cause the temperature inside the sphere or cabin to rise. This raise in temperature will be sensed by the thermostat **30** and humidity control **29** activating the heat exchanger pump **22**, thus moving coolant through the coils of HE II **24**, and thereby lowering the air temperature and humidity. However, if the cabin temperature should decrease and the humidity remains high, the coolant pump **22** is stopped; the air is no longer cooled; but excess humidity is removed by a desicant such as silica gel **25**. The system is designed to support three men for 12 hours with a safety factor of 300 percent with minimum power requirements. The crew compartment is kept warm by the heat generated by three men, electric equipment, and the CO_2 scrubber. This heat will be retained by the insulation of the hull.

In summary, the cooling system, which is the subject of the invention, is a cold source heat exchanger system located below the false floor of the cabin of a deep submersible

system. This cold source is filled with a substance having a low freezing point and a high specific heat. This substance is then super-cooled (frozen) by attaching the submersible system to the mother ship refrigeration system just prior to launching the deep submersible vessel. Then the coolant from the deep submersible vessel air cooler is passed through the heat exchanger tubes in the cold source. The only power required is that necessary to pump the air cooler coolant.

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.

What we claim is:

1. A cooling component control of a system for sustaining life in a submersible vehicle, said vehicle including a cabin with a false floor, and a life sustaining system including a cooling component comprising in combination:

a. medium of high specific heat positioned below the false floor;

b. external refrigerating means for super-cooling said medium to its freezing point;

c. a first heat exchanger located in said medium;

d. external refrigerating means being intermittently operatively connected to said first heat exchanger;

e. a second heat exchanger located in the cabin;

f. an accumulating tube operatively connected between said first and second heat exchanger;

g. said accumulating tube containing a heat removing fluid;

h. pump means operatively connected between said first and second heat exchangers and the accumulating tube to control the circulation of said fluid.

2. The apparatus recited in claim 1 wherein the medium of high specific heat is a salt-brine.

3. The apparatus recited in claim 1 wherein the medium of high specific heat is a blue-ice gel.

4. The apparatus recited in claim 1 wherein the heat exchanger consists of refrigeration coils.

5. The apparatus recited in claim 4 wherein the second heat exchanger comprises a humidity removal means and condensate collector.

6. The device recited in claim 1 wherein the external refrigerating means is a shipboard refrigeration unit intermittently operatively connected to said first heat exchanger consisting of refrigeration coils.

7. The device recited in claim 1 wherein the heat removing fluid is a water-glycol solution.

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