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Bayles

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[54] **HYDRAZINE FUELED DIVER'S HEATING SYSTEM**

[75] Inventor: **John J. Bayles**, Oxnard, Calif.

[73] Assignee: **The United States of America as represented by the Secretary of the Navy**, Washington, D.C.

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[52] **U.S. Cl.** ..... **126/204**; 60/218; 126/263; 128/142; 128/191 R

[51] **Int. Cl.** **A61f 7/06**

[58] **Field of Search** ..... 60/218, 219; 126/204, 263; 128/142, 191 R

[56] **References Cited**

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Primary Examiner—William F. O'Dea
Assistant Examiner—Peter D. Ferguson
Attorney, Agent, or Firm—Richard S. Sciascia; Joseph M. St. Amand

[57] **ABSTRACT**

Apparatus for heating water used for the welfare of divers in cold water environments comprising a hydrazine fuel canister, a means of pressurizing the fuel, a means of transferring heat from the fuel to a closed water system and a pump device for circulating water through a closed circuit in the diver's suit. Extra heat may be used in heating a CO_2 absorbent canister.

8 Claims, 3 Drawing Figures

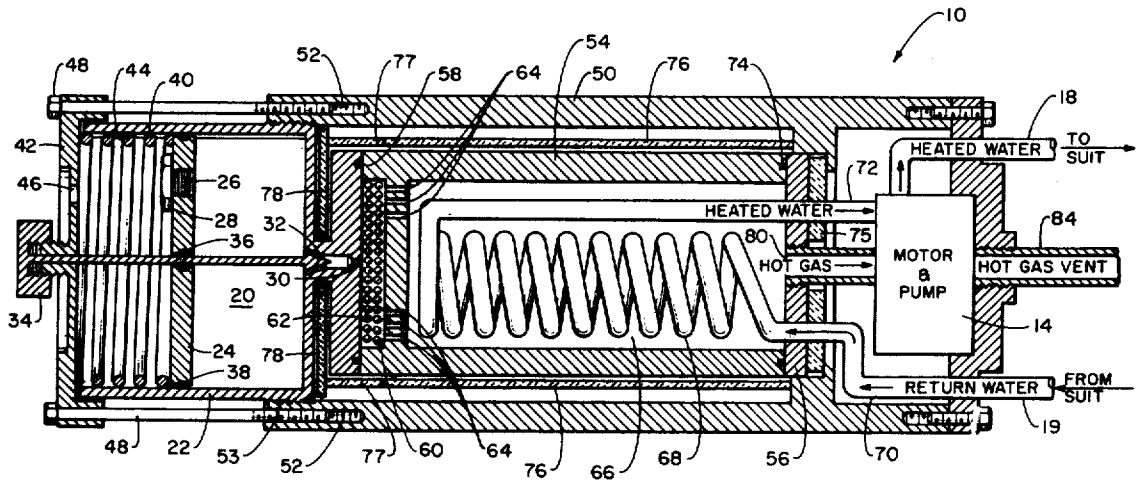


Fig. 1.

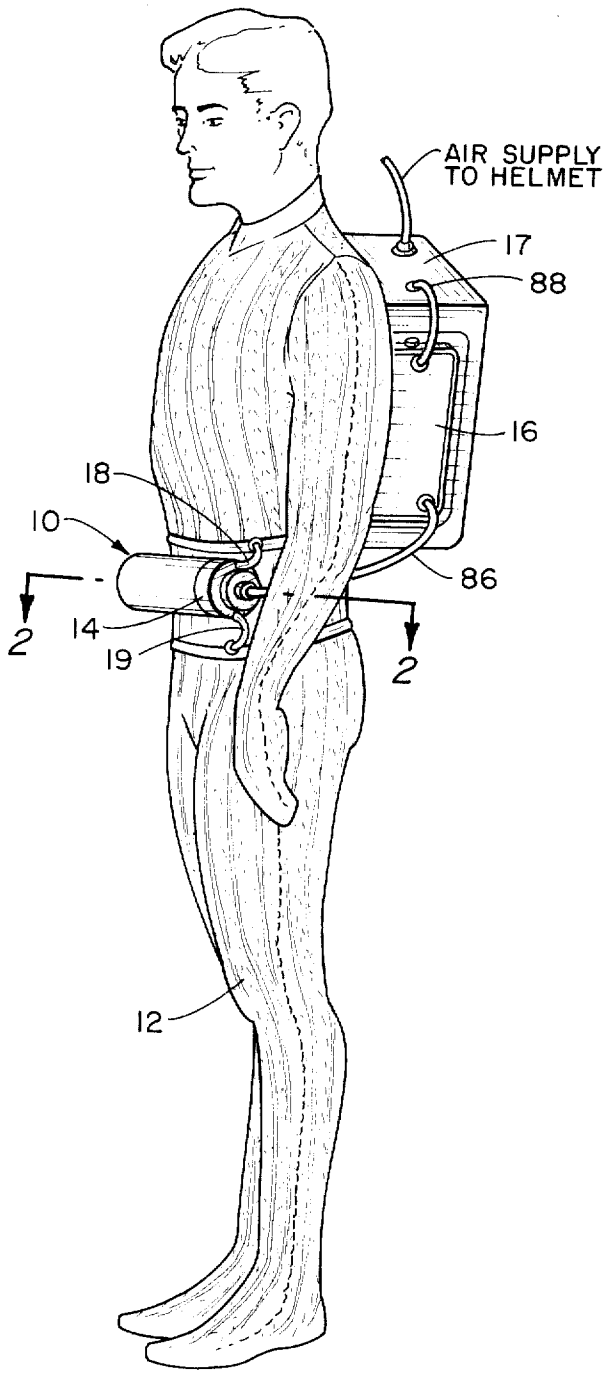
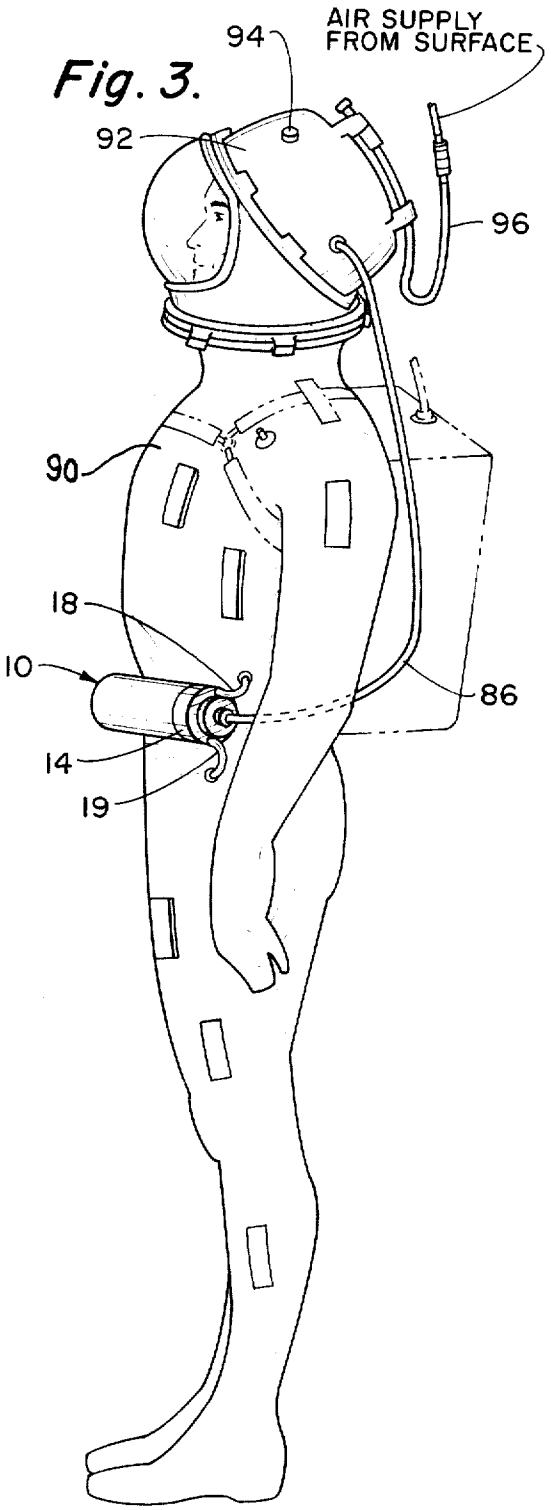

AIR SUPPLY
TO HELMET
17
88
16
18
10
86
2
14
19
2
12

Fig. 3.


94
AIR SUPPLY
FROM SURFACE
92
96
90
18
10
86
14
19

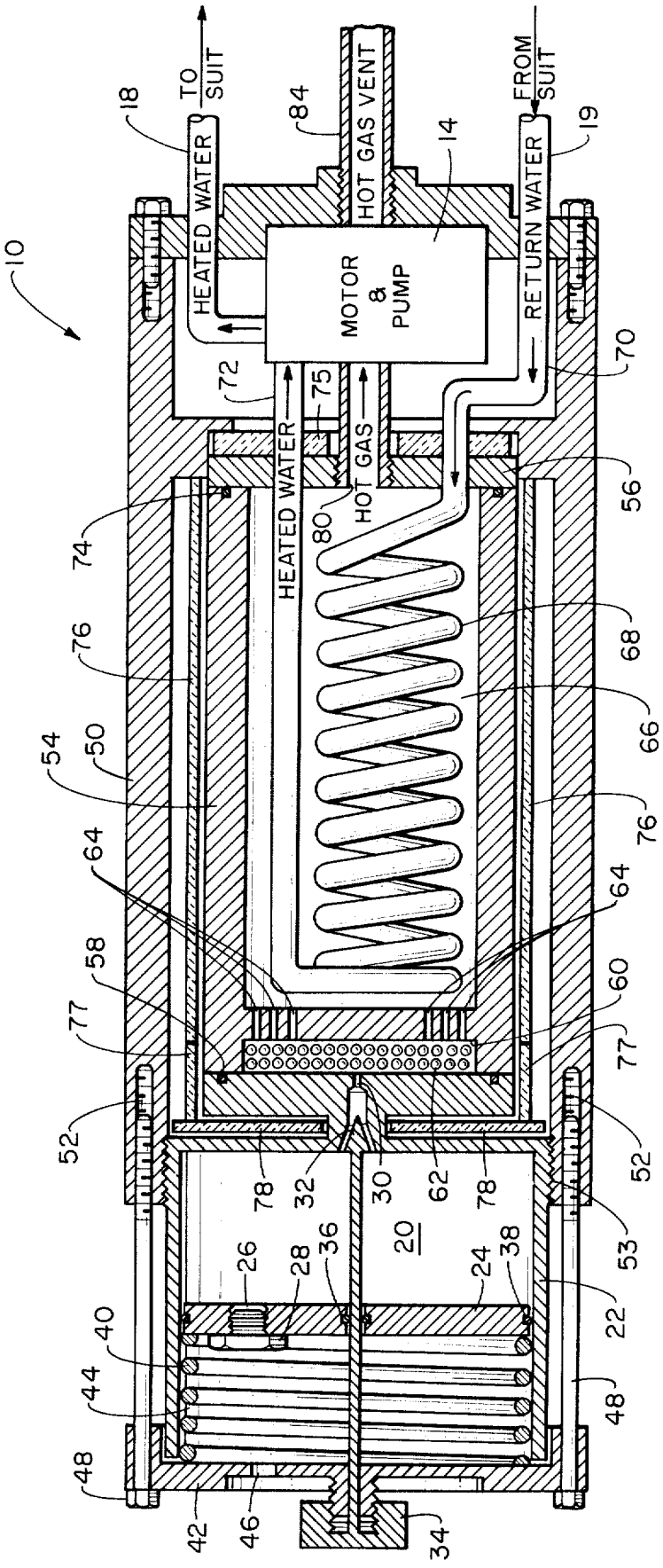

10
18
TO SUIT
HEATED WATER
84
HOT GAS VENT
14
FROM SUIT
19
RETURN WATER
MOTOR & PUMP
72
75
70
HEATED WATER
HOT GAS
80
74
56
76
68
66
54
50
64
58
77
60
52
78
32
30
62
20
26
28
36
24
38
40
44
48
42
46
34
22
53

Fig. 2.

HYDRAZINE FUELED DIVER'S HEATING SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to a water heater and more particularly to an apparatus for heating a liquid such as water to be used for the welfare and comfort of diver/-swimmers in cold water environments.

For military and commercial purposes it is becoming increasingly desirable to place divers in hostile cold water environments below the ocean surface, sometimes at great depths. Hence the necessity to provide means for conserving the diver's body heat to improve his efficiency and effectually preserve his life in extreme circumstance. Various means have been approached, with varying degrees of success. An attempt to solve the problem through use of an isotopic heating element has proved both impracticable and exorbitantly expensive. A method utilizing heat of crystallization is still in an early experimental stage. A more successful method has heated water in a fuel fired water heater and the heated water pumped from the surface to the diver. Electrical grid resistance suits have been experimented with and a diver mounted electrical water heater has received some attention. Each of these last methods requires that the diver/swimmer be tethered by one or more umbilicals. Use of umbilicals presents a number of disadvantages including reduced efficiency of the systems and restriction of diver capability.

The present invention solves many of the above mentioned difficulties by providing a simple diver mounted apparatus which incorporates positive operation. Furthermore, this invention permits the diver/swimmer to be freed from any tether when the occasion arises. Desirable additional advantages are practicable when the invention is in use. By-products of the fuel decomposition may be used to drive the pump which circulates a warmed liquid such as water through the tubing of the diver's garment or protective suit and may be used to warm the carbon dioxide absorbent canister when the diver is on a semiclosed or closed circuit mixed gas breathing system. The warming of the canister improves the efficiency of the absorbent.

SUMMARY OF THE INVENTION

The present apparatus for heating water or other suitable liquids for use in reducing the body heat losses of diver/swimmers in a cold water environment is simple, compact, serves more than one function and includes: a self-contained, self-pressurized fuel; a catalyst bed for decomposing the fuel exothermically; an insulated heat exchanger and a means for pumping heated water through a closed-circuit tubing diver's dress.

Advantages over other diver heating systems are achieved in the present invention by providing an apparatus comprising a fuel canister; a means for pressurizing the fuel; a means for metering the fuel; a means for decomposing the fuel exothermically; a means for transferring the heat to a closed-circuit water system; a means for pumping the water through the closed-circuit; and exhausting the remaining heat over the CO_2 absorbent canister for improving its efficiency. The heat exchanger component is also provided with means for conserving heat. In addition to use underwater, the present heating system has use in other environments, such as in outer space.

OBJECTS OF THE INVENTION

It is an object of the invention to provide a water heating apparatus which is simply constructed, reliable and compact.

Another object of the invention is to provide a water heating apparatus which will provide a means by which a reduction of diver/swimmer body heat losses will be achieved and overcome.

A further object of the invention is to provide means for untethered excursion by divers in a cold water environment to extend the range of underwater activity.

Still another object of the invention is to improve the efficiency of the CO_2 absorbent in a divers mixed gas breathing system.

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

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagrammatic view of one embodiment of the invention as worn by a diver.

FIG. **2** is a diagrammatic section view of the fuel container/heat exchanger of the present invention taken along line **2—2** of FIG. **1.**

FIG. **3** is a diagrammatic view of another embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, wherein like reference numerals designate like parts, there is shown in FIG. **1** an embodiment of the present invention comprising a fuel container/heat exchanger **10,** a diver's tubing suit **12,** a water pump **14** on the end of fuel container **10,** and a jacketed CO_2 absorbent canister **16** carried on the diver's back along with the air tank **17** that supplies air to a diver's helmet which is not shown. Water heated in fuel container **10** is circulated through suit **12** by means of a motor pump **14.**

Tubing suit **12** is similar to the type used by astronauts. Heated water flows from the pump **14** to the suit via an outlet tube **18.** Tubing in suit **12** normally has a manifold system, in the waist area, to distribute the heated water to several circuits throughout the suit. The water then returns to the fuel container/heat exchanger **10** via return tube **19.**

FIG. **2** illustrates one embodiment of the fuel container/heat exchanger **10** where **20** is the fuel cavity enclosed by cylinder **22** and piston **24.** The fuel cavity **20** is filled with hydrazine through a port **26** shown closed by plug **28.** Fuel metering through orifice **30** is controlled by valve **32** which is operated by rotating control knob **34.** The O-rings **36** and **38** on piston **24** seal the fuel chamber at the piston. Spring **40** acting under compression between cap **42** and piston **24** provides fuel pressurization above ambient pressure at any underwater depth because the chamber **44** containing spring **40** is open to ambient pressures through port **46.**

Screws **48** secure cap **42** to the heat exchanger housing **50,** by threading into drilled and tapped receivers **52.** The heat exchanger housing **50** is screwed onto cylinder **22** at **53** to assemble and retain cylinder **54** and end plate **56** in compression. O-ring seal **58** ensures the integrity of the catalyst bed chamber **60** containing the catalyst **62** which decomposes the hydrazine fuel. Ce-

ramic pellets coated with Iridium, for example, are used as the catalyst. Depending upon the design of catalyst bed **60**, the hydrazine will break down by exothermic reaction to form primarily Hydrogen, NH_4 gas and some Nitrogen at around 1,200°F. As the hydrazine fuel from cavity **20** is metered at valve **32**, by manipulation of control **34**, through orifice **30** into catalyst bed **60**, the resulting hot gases pass through multiple peripheral orifices **64** into the heat exchanger compartment **66** where heat exchanger coil **68** absorbs heat and transfers it to water, e.g., circulating through the coil from the inlet side **70** to the outlet side **72**. O-ring seal **74** ensures the integrity of the heat exchanger compartment **66**. Insulation **75**, **76**, **77** and **78** isolate heat exchanger coil **68** and catalyst bed **60**, **62** and conserve the heat generated by the hydrazine fuel decomposition. Insulation **78** can be a split disc.

Exhausting gas is ported through **80** where it enters motor and pump **14**. The hot gases operate a turbine motor, for example, which drives the pump. Motor and pump **14** forces the heated water from heat exchanger coil **68** through the tubing system of the diver's suit. Heated water exits the heat exchanger at **72** passes through motor and pump **14** into the suit via a valved quick connect tube **18**. The heated water is circulated through the tubing of the suit and then exits from the suit via another valved quick disconnect tube **19** for return to the heat exchanger **68**. The water may be pumped as it exits or as it returns to the heat exchanger, as a matter of choice.

The exhausting gases which pass through and drive motor and pump **14** exit at vent **84** where the gases can pass via tubing **86** to the jacket about the CO_2 absorbent canister **16** where the hot gases are used to heat the CO_2 canister. Heating of the CO_2 canister serves to improve the operation thereof since the absorbent in the canister absorbs more CO_2 in the breathing system air supply **17** when warm than it does when cold. The gases are then vented away through valve **88**. Valve **88**, may otherwise be located at the exit **84** from the motor and pump. The CO_2 absorbent typically is a combination of barium, calcium and potassium hydroxides.

As illustrated in FIG. **3**, the heated water is pumped from heat exchanger **10** into the heat circulation system of the diver suit **90** via a valved quick disconnect tube **18**, as in FIG. **1**, and after circulating through the suit is returned via valved quick disconnect tube **19** to the heat exchanger. Where an air supply back pack is not used, gas exhaust tube **86** can be connected to the jacket about a CO_2 absorbent canister in a helmet **92** as shown in FIG. **3**, and the gases vented away through a valve **94**. As shown in FIG. **3**, if desired, the diver air supply is provided to helmet **92** through an air supply line **96** from the surface. However, air to the helmet can be supplied from air tanks carried on the diver's back, as in FIG. **1**.

Where a tether line is provided to supply air from the surface, such as in FIG. **3**, another source of energy, e.g., electric, when desired, could be provided to power the motor and pump **14** rather than using the hot gases from the heat exchanger. However, the multiple use of the hot gases from the heat exchanger is an added advantage of this invention. In the present system, the hot gases, in addition to heating the water which in turn heats the diver suit, also drive the motor and pump, and heat the CO_2 canister, thereby eliminating the need for an umbilical line to the surface for providing power to the motor and pump.

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 claimed.

What is claimed is:

1. A self-contained, portable heating system for providing warmth to a wearer in a low temperature environment, comprising:

a. a body protective suit having a heat distributing means therein for distribution of heat throughout the suit;

b. a heat generating means connected to the heat distributing means of said protective suit for providing a portable heat source therefor;

c. heat transfer fluid operatively associated with said heat generating means and said heat distributing means;

d. pump means cooperating with said heat generating means and heat distributing means for pumping said heat transfer fluid through said heat generating means and throughout the heat distributing means of said protective suit;

e. said heat generating means comprising:

1. a fuel container containing hydrazine fuel,

2. a heat exchanger housing including a heat exchanger coil through which said heat transfer fluid is circulated,

3. an enclosed catalyst bed containing suitable catalyst material for exothermic decomposition of said hydrazine fuel connected between said fuel container and said heat exchanger housing,

4. a fuel metering means between said fuel container and said catalyst bed for controlling the flow of hydrazine fuel to said catalyst where it is converted by exothermic reaction into hot gases,

5. passageways between said catalyst bed and said heat exchanger housing whereby the hot gases generated are permitted to flow about said heat exchanger coil for heating the heat transfer fluid circulated therein

f. means for exhausting expended hot gases from said heat generating means;

g. a breathing system including a CO_2 absorbent canister also carried by the wearer of said protective suit wherein hot gases exhausted from said heat generating means are used to heat the CO_2 absorbent canister for more efficient operation thereof.

2. A system as in claim **1**, wherein hot gases from said heat generating means are used to operate said pump means.

3. A heat generating means as in claim **1** wherein said catalyst material consists of iridium coated ceramic pellets.

4. A heat generating means as in claim **1** wherein said hot generated gases are at a temperature of about 1,200°F.

5. A heat generating means as in claim **1** wherein said heat exchanger and catalyst bed are insulated to conserve heat generated by said hydrazine fuel decomposition.

6. A heat generating means as in claim **1** wherein a pump means attached to said expended hot gas exhaust means operates to pump the heat transfer fluid through

said heat exchanger coil for circulation throughout said heat distributing means.

7. A system as in claim 1 wherein an exhaust port is provided for venting said expended hot gases from the system following heating of said CO_2 canister.

8. A system as in claim 1 wherein said fuel metering means is an adjustable valved passageway.

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