

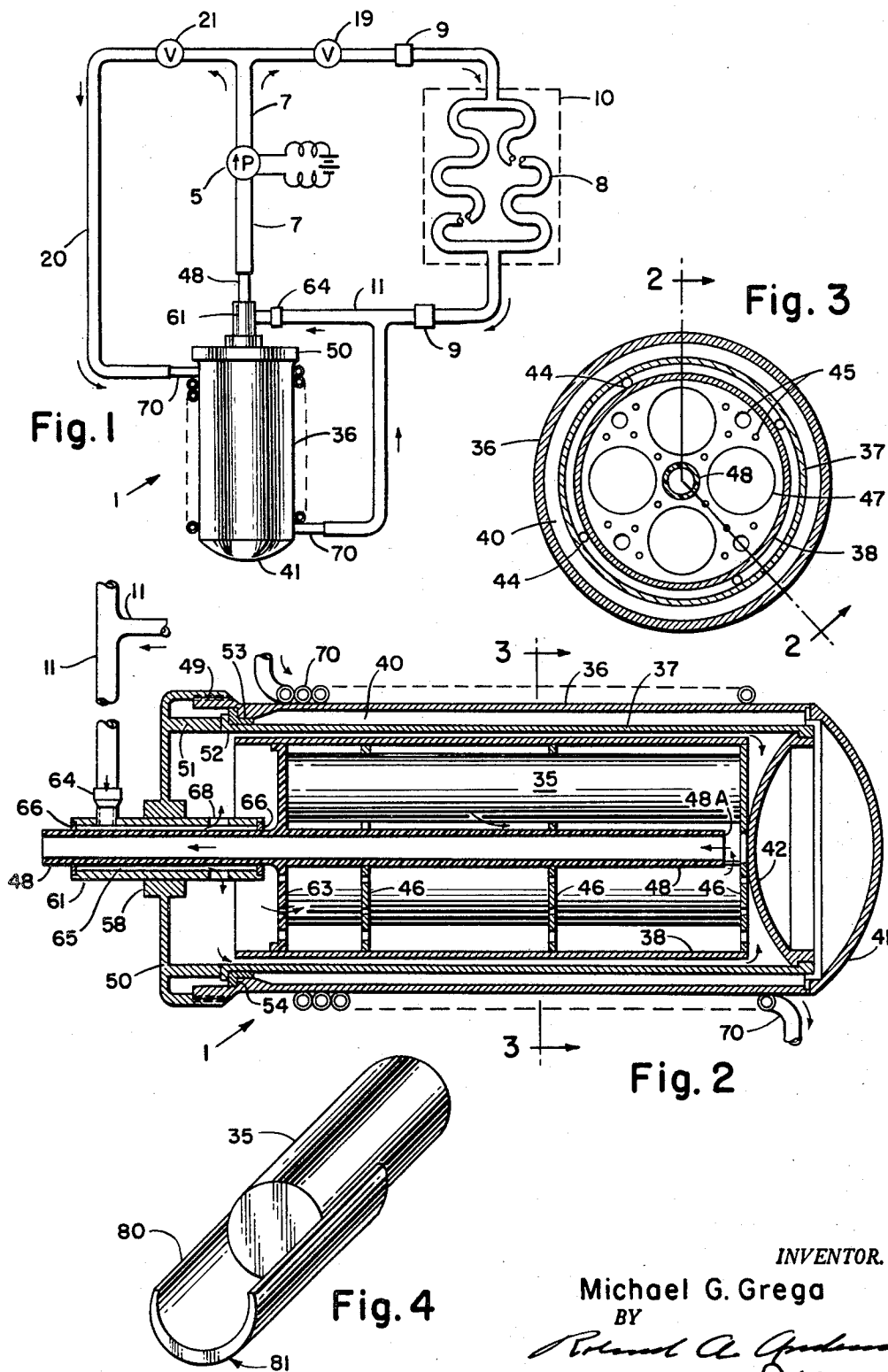
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SUIT HEATER

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SUIT HEATER

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ABSTRACT OF THE DISCLOSURE

Apparatus for heating garments such as suits for swimmers or astronauts who may be subjected to cold water or space environments, which utilizes a radioisotope heat source to furnish heat to fluid that is pumped through conduits or passageways of the apparatus and garment, and which includes means for selectively bypassing fluid so as to vary the temperature of fluid pumped through the garment passageways.

Background of invention

One of the hazards to swimmers or astronauts is low temperatures. For example, even tropical waters do not match the human body temperature of about 98.6° F. (37° C.). Additionally, the thermal gradient of waters drops with increasing depth. Most deep diving is performed in ambient temperatures 25° to 50° below normal human temperature. The result is that, as a function of exposure time, body temperature gradually decreases. Physiologically, the important temperature measurement is the core temperature (the inner body temperature measured at about heart level). Body protective measurements are designed to protect this core temperature. If the core temperature begins to diminish the effectiveness of body function is affected and human performance deteriorates. At first the core temperature drops gradually but more rapidly later, as a function related to water temperature and time.

In deep diving operations a helium oxygen gas is generally used. Helium is a light gas and minimizes or overcomes the problems of ordinary air becoming very dense under pressures greater than 100 feet. It also minimizes or eliminates the narcotic effect of nitrogen. However, it is a poor insulator and causes personnel exposed to low temperatures found at deep depths to lose body heat faster.

The human body responds to lowered core temperature by a shivering and teeth chattering response. Numbing cold sets in. A diver with self contained underwater breathing apparatus (SCUBA) having such response is ineffective and in danger. When the shivering and teeth chattering state is reached, the diver-swimmer is no longer capable of holding a SCUBA mouthpiece in place or of performing useful work.

Protective suits made of foam rubber are good for relatively short periods of time of about 2 to 3 hours in the water. However, the colder the water, the shorter this effective period will be. Additionally, the foam is compressible and therefore, less insulative with increasing depth.

Heated suits utilizing various power sources are required for long periods of time. There exist at present electrically heated suits, which require approximately 25 pounds of batteries and which last 1 to 3 hours before recharging, but these are bulky and expensive to operate.

The most desirable solution appears to be a circulating hot water system that an occupant or wearer plug into and out of. The swimmer would wear a suit embedded with vein-like tubes or passageways, which would carry and through which would circulate the heated water (similar suits are used by astronauts, aviators and racing car

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drivers to keep cool by use of a coolant fluid in the tubes).

In the case of the swimmer or diver heat to be supplied to transfer fluid in the suit passageways would by this invention come from a radioisotope backpack heater capable of furnishing around 300 to 400 thermal watts for maintaining body temperature. In addition to use for underwater swimmers, the unit may be used by downed pilots or suits for land operations in the Arctic and Antarctic.

Summary of invention

With the foregoing in mind, it is an object of this invention to provide a compact, relatively light weight apparatus or device for furnishing heated fluid to a garment.

Another object of this invention is to provide an apparatus for supplying heated fluid to a garment that may be operated for relatively long periods of time without need of rejuvenation.

A further object of this invention is to provide an apparatus capable of furnishing ample heat output over relatively long periods of time.

Various other objects and advantages will appear from the following description of the invention and its features.

The invention comprises container means which houses a shielded radioactive isotope heat source or capsule with heat transfer fluid being pumped over the heat source and through passageways of a garment including a selectively controllable fluid bypassing means to facilitate controlling temperature of fluid to the garment.

Description of the drawings

Various embodiments and features of the invention are shown in the accompanying drawing wherein:

FIG. 1 is a diagrammatic view of the invention;

FIG. 2 is a longitudinal sectional view of the heater shown in FIG. 1;

FIG. 3 is a view taken generally along line 3—3 of FIG. 2; and

FIG. 4 is a perspective view of a radioactive isotope heat source and shield.

Detailed description

FIG. 1 illustrates diagrammatically the flow (see arrows) of a heat transfer fluid, which may be a gas or liquid such as water but which is preferably the latter, through a heater 1 and garment 10 via the interconnecting conduits and couplings. Heater 1 and its operation will be described more fully hereinafter with respect to FIGS. 2 and 3.

The fluid may be moved by any suitable pump 5 from hot water outlet pipe 48 of heater 1 through outlet conduits 7, through commercially available quick connect-disconnect couplings 9, and thence flexible, vein-like conduits or passageways 8 of garment 10, which may be a swim suit or astronaut suit. The passageways and manifolds of the garment 10 may be of any appropriate configuration and may connect in any suitable manner to the above-mentioned fluid delivery conduit or passageway 7. Upon emerging from garment 10 the fluid is shown to flow through passageway 11 back into cold water inlet 64 of heater 1.

The pump 5 and its driving motor which move fluid through the various conduits or passageways may be of any appropriate type, e.g., a commercially available electrically driven (constant or variable speed) one as available from Normalair, Ltd. and the motor may be driven by any suitable power system, e.g., one or more batteries 17 such as silver-zinc rechargeable types commercially available from Yardney Electric Corporation or others.

A hand operated valve 19 may be provided in the conduit 7 for selectively controlling the quantity of fluid pass-

ing through that conduit and the garment passageways 8 and thereby controlling the quantity of heat which is received by the diver or astronaut. A commercially available needle or other valve may be utilized, with the container handle being readily accessible to and actuable by the wearer. To further facilitate desired control of the fluid and circulation through heater 1 and garment 10, there is provided a bypass conduit 20 and a similar needle or other type valve 21 therein for transferring fluid from the outlet side of the pump 5 and returning through bypass heat exchanger portion 70 and conduit 11 to cold water inlet 64 of heater 1, prior to the thus bypassed fluid reaching the passageways of the garment 10.

It may be deemed desirable to provide offset conduit arrangements and radioactivity shielding adjacent portions where conduits enter or emerge from heater 1.

In FIGS. 2 and 3, heater 1 includes radioisotope fuel cells or capsules 35 housed within a plurality of containers 36 and 37 and carried by holding means 38 shown of generally tubular exterior configuration. The outer container 36 and additional or intermediate container 37 cooperate to form an intermediate volume 40 which may be under reduced pressure, the amount of reduced pressure being dependent on the desired insulating characteristics (to reduce heat loss through the walls), being closed at their respective ends by outer end cap 41 and additional end cap 42. It will be noted that the latter end caps are bowed in opposite directions so as to provide greater strength against collapse when the volume 40 is evacuated. Additionally, the surfaces of these cylinders may be polished so as to further minimize heat loss.

The holding means or further container 38 is retained in position and spaced from the walls of the intermediate container 37 by circumferentially spaced elongated wire wedging members 44 so as to provide space between these two containers for passage of fluid therebetween and the radioisotope fuel or heat capsules are shown maintained in position within the holding means by longitudinally spaced capsule support members 46. The support members 46, which may be welded or otherwise retained in position, carry the capsules in apertures 47 and are also provided with apertures 45 throughout their areas for freely passing fluid flow therethrough, as well as with a centrally disposed aperture for receiving portions of a hot water conduit or pipe 48 that will be more particularly referred to later.

The concentric containers 36, 37, and holding means 38, and caps 41 and 42, capsule support members 46, and spacer wires 44 may be of anodized aluminum, or any other suitable materials and the end caps 41 and 42 may be joined or welded to their respective cylinders in any suitable manner.

The outer and additional containers may be positioned and secured together by an end or top cap 50 shown threaded at 49 to the outer container 36, with an inwardly extending flange 51 bearing against an end shoulder 52 of the additional container 37 so as to force the latter firmly into engagement with an O-ring or spacer 53 of "Plexiglas" (polymerized methylmethacrylate), "Teflon" (polytetrafluoromethylene), or other suitable material. The spacer 53 rests in turn against inwardly extending shoulder or ledge 54 of the outer container 36 and not only forms a secure vacuum tight seal between the outer and additional containers but also provides a thermal insulation between these two containers.

The end or top cap 50 has an enlarged boss 58 which supports the penetrating cold water inlet sleeve 61 and through the latter extends the hot water outlet tube 48, the latter extending through the central apertures of the fuel cell supporting members 46 and terminating adjacent but spaced from the end cap 42.

Cold water from a conduit may enter the cold water inlet member 64 and emerge therefrom into the annular cold water space 65. The cold water sleeve is sealed or closed adjacent its end portions to hot water sleeve 48 by

cap members 66 and hence the entering cold water emerges from the sleeve 61 through apertures 68 at inwardly disposed portions of the sleeve, thence flowing through the annular space intermediate the exterior of the innermost container 38 and adjacent wall of container 37, as well as through apertures in the integral supporting and positioning flange 63 of the hot water tube 48 and the various openings in the fuel cell support members 46. In thus flowing through the noted openings and spaces the fluid picks up heat given off by the fuel cell units. After flowing in heat-removing contact with the fuel cell units and portions of the support means or container 38 the heated fluid enters the upper or inlet end 48A of the hot water tube 48 and flows therethrough, at a speed of around an inch or two per second, entering upon its emergence from the tube 48 (at a temperature in the neighborhood of 100° F. to 120° F.) the appropriate tubing which leads toward a garment 10 that is to be heated.

The end or top cap member 50 may be of anodized aluminum, as may be the cold water sleeve 61 and the cold water inlet member 64. The hot water tube 48 and its integral supporting flange portion 63 may be of plastic such as polyvinyl chloride as such material provides a thermal insulation between the hot and cold flowing streams of fluid. The end members or caps 66 of the cold water sleeve 61 may be cemented into position on both the cold water sleeve and the hot water tube by any suitable adhesive material and the cold water sleeve may be similarly cemented together with the cold water inlet member 64 and boss 58 of the end member 50.

With the construction shown in FIG. 2 fluid bypassed by and emerging from a bypass valve does not directly re-enter the containers but instead first passes through a bypass heat exchanger coiled portion 70, of aluminum, copper, brass or any other suitable material shown coiled about the exterior of the outer container 36 and thence returns via conduit 11 to the cold water inlet member 64 as indicated (see arrows) and to the interior of a container. If a diver becomes too warm he can bypass some of the hot water through the bypass coil by opening the bypass needle valve, so that hot water circulates through the coil and its temperature approaches that of the surrounding ocean, after which it re-enters the main flow of water.

If considered desirable, the heat sources can be removed by unscrewing the top cap 50.

While four radioisotope heat or fuel capsules are indicated in FIGS. 2 and 3, any appropriate member may be employed, depending upon the desired thermal output. Preferable radioisotopes are alpha or beta emitters with low radiation emissions. Plutonium 238 or an alloy thereof is satisfactory. Other isotopes which may be employed are polonium 210, promethium 147, curium 242, curium 244, americium 241, thulium 170, thulium 171, thallium 204, cesium 137, cerium 144, strontium 90, etc. In general, about 300 to 400 thermal watts output is desirable for underwater swimmers at underwater temperature of around 45° F.; additional heat may be desirable for astronauts in the cold of outer space or downed pilots in frozen areas.

Using four heat sources which incorporate plutonium 238, the individual sources supply approximately 105 watts of thermal power. The heat sources may be stored apart from the device when not in use and may be installed just prior to a mission after the swimmer is "suited."

An idea as to compactness of the heater assembly of FIG. 2 may be obtained from its dimensions of approximately 12 to 13 inches long and 4 inches in diameter, with a weight of around 20 pounds.

The described apparatus which furnishes heat for a garment need not, of course, be permanently assembled with the flexible tubing of such garment but may be in the form of a backpack or other unit which may be

readily assembled or removed therefrom by means of suitable quick disconnect couplings 9.

No radioactivity shielding is shown in the FIGS. 2 and 3 apparatus as such may be dispensed with in some instances since the water in which a swimmer is located provides at least partial radiation shielding. Suitable permanently emplaced or removable radioactivity shielding may be utilized depending on the radioisotope used in the fuel cells and the expected exposure of the swimmer such as lead, tantalum, hydrogenous materials or other conventional shielding materials.

FIG. 4 illustrates one form of radioactive shielding which may be used. Fuel cell 35, as shown, may be partially enclosed by generally arcuate shield 80. Shield 80 may be positioned on each of cells 35 in FIGS. 2 and 3 facing radially outward so as to provide complete shielding around the periphery of heater 1. The radial shielding effects of shield 80 may be further enhanced by increasing the cross-sectional dimension at its center portion 81. It will be apparent that the shapes of apertures 47 may be varied to accommodate shield 80. End cap shields (not shown) may be positioned over the ends of fuel cells 35 to provide shielding along the longitudinal axis of heater 1.

It will be understood that various changes may be made by those skilled in the art within the principles and scope of the invention as expressed in the appended claims.

What is claimed is:

1. For use with a garment to be heated through a fluid passageway therein, apparatus to supply heated fluid to said passageway, said apparatus comprising an outer container, an additional container within said outer container and spaced therefrom to provide an evacuable volume therebetween, holding means within said additional container for supporting a radioisotope heat source for fluid flow therearound, an apertured cap member secured to said outer container and positioning said additional container and holding means within said outer container, conduit means for transmitting fluid from the interior of said additional container to said garment passageway and

back to said additional container, pumping means for moving fluid through said conduit means and additional container, a fluid bypass conduit communicating with said conduit means at a location in advance of entry into said garment passageway and with said additional container for diverting fluid from the conduit means prior to entering said garment passageway, and valve means for selectively controlling movement of fluid through said conduit means and said bypass conduit.

2. Apparatus as claimed in claim 1, wherein said holding means has an exterior portion of generally tubular configuration spaced from said additional container for fluid flow therebetween.

3. Apparatus as claimed in claim 1, wherein said fluid bypass conduit includes a portion extending along the exterior of said outer container.

4. Apparatus as claimed in claim 3, wherein said portion of the bypass conduit is coiled around the outer container.

5. Apparatus as claimed in claim 1, wherein means is provided for removably supporting a plurality of fuel elements within said inner container.

6. Apparatus as claimed in claim 5, wherein means is provided for delivering cold fluid to the inner container adjacent one end thereof and for withdrawing heated fluid through the cold fluid delivery means.

7. Apparatus as claimed in claim 1, wherein removable radioactivity shielding means is provided for said radioisotope heat sources.

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