

[54] **HOT WATER HEATER SYSTEM FOR DIVERS**

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

[58] Field of Search **126/204, 208, 210, 126/362**

[56] **References Cited**

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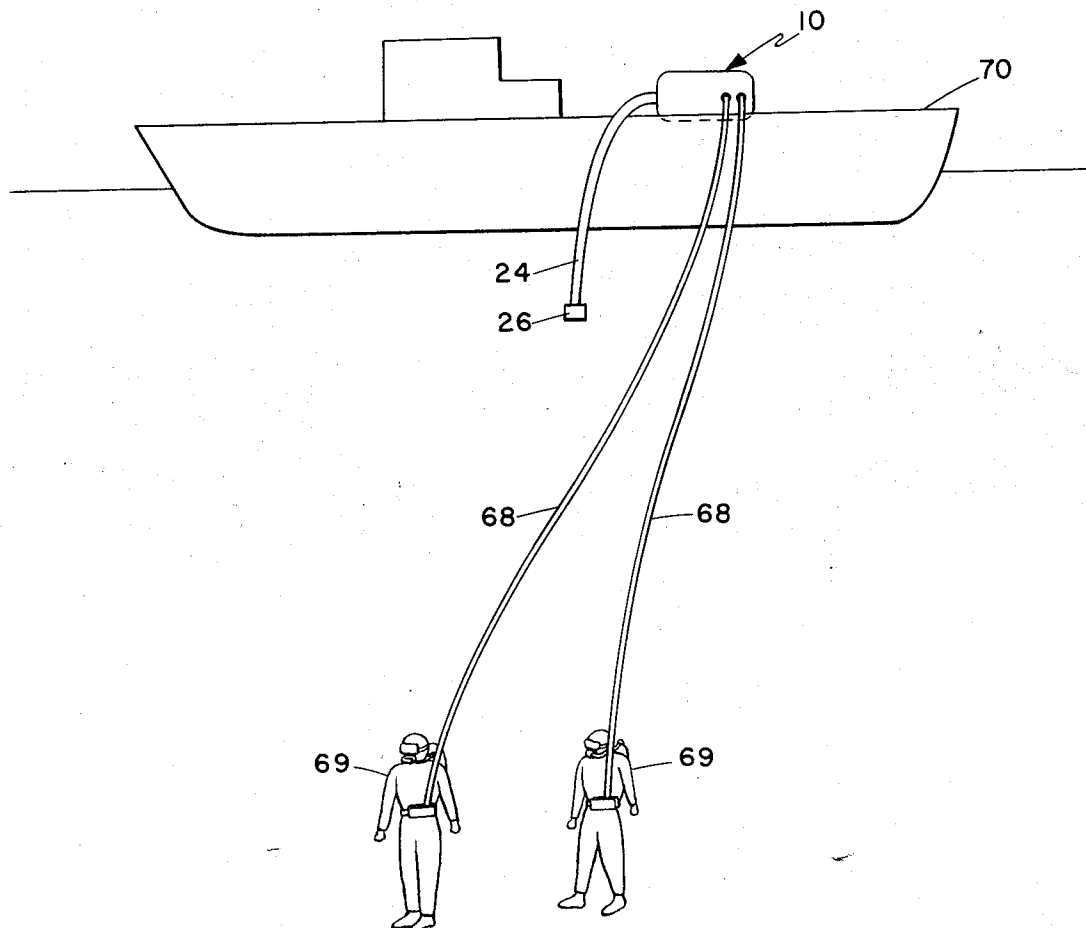
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[57] **ABSTRACT**

A system for delivering heated water to divers including a circulation system having a source of heat and a heat exchanger for transferring the heat to water in the circulation system, and a supply system utilizing centrifugal pumps to deliver water to the circulation system. The circulation system has sufficient volume so that the fluctuation in temperature caused by variation in the amount of water demanded by the diver or divers is minimized. An automatic temperature controlled device is provided to regulate the temperature of the water delivered to the diver by mixing controlled amounts of unheated water with water from the circulation system heated to a temperature in excess of that required.

1 Claim, 4 Drawing Figures



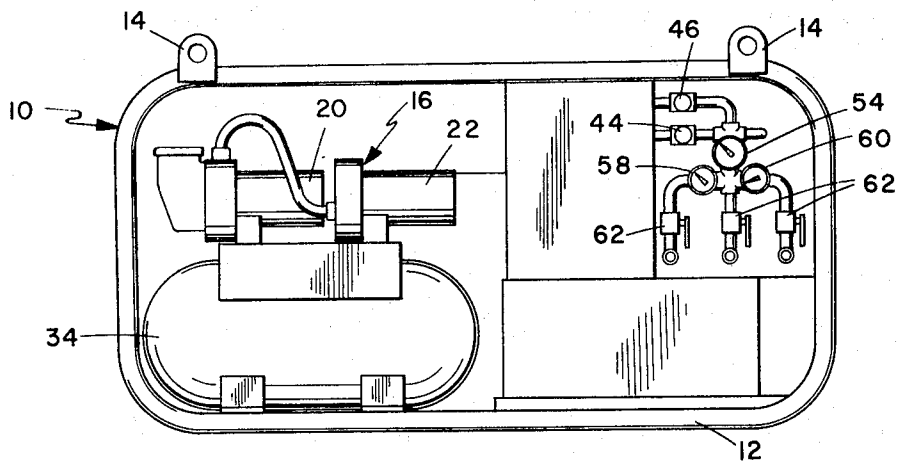


Fig. 1

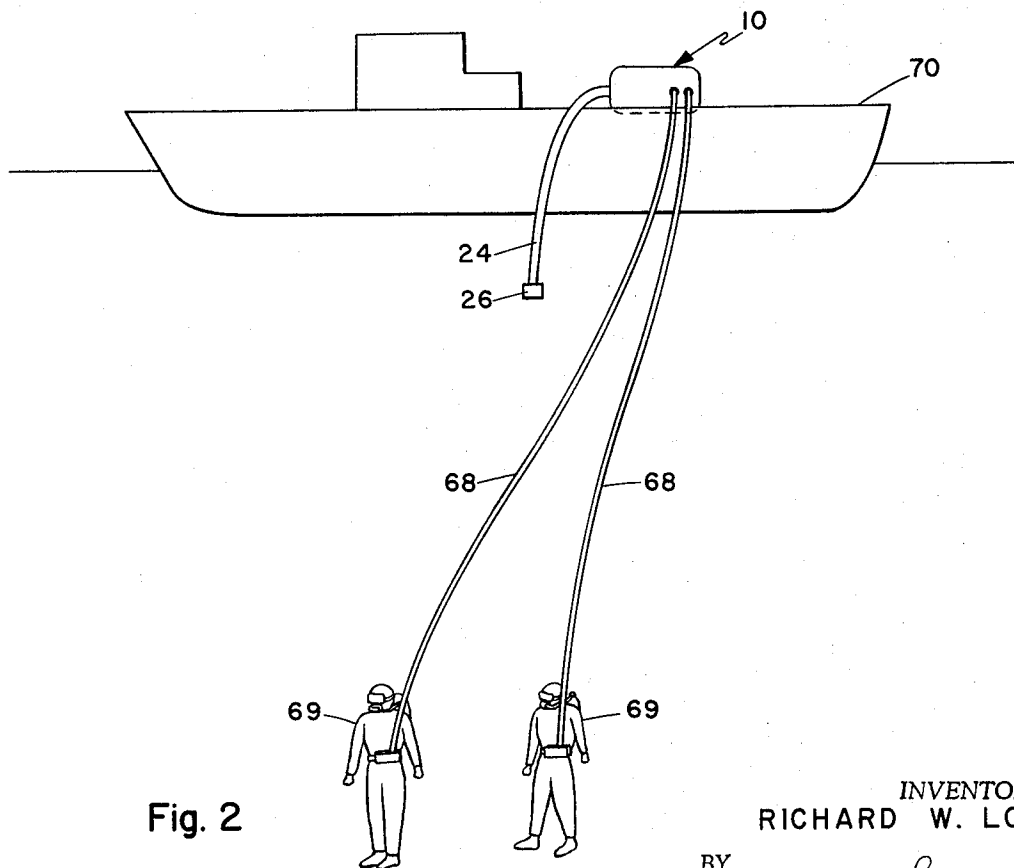


Fig. 2

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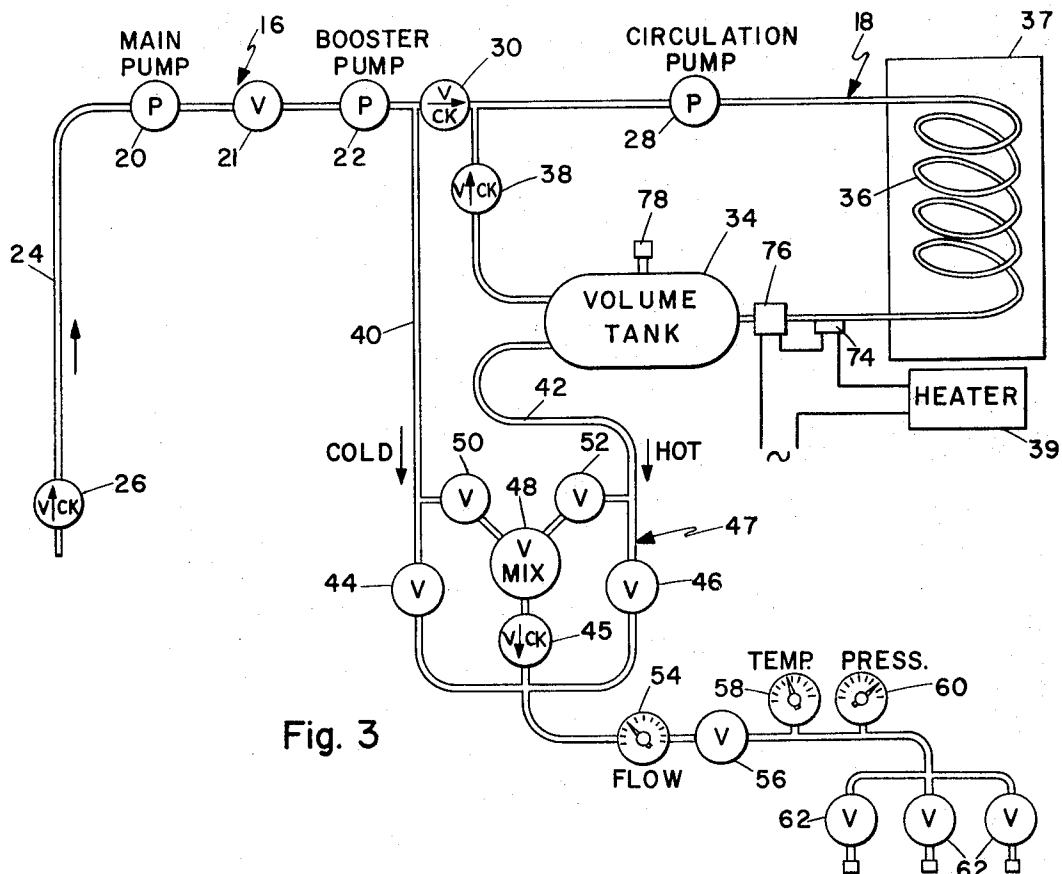


Fig. 3

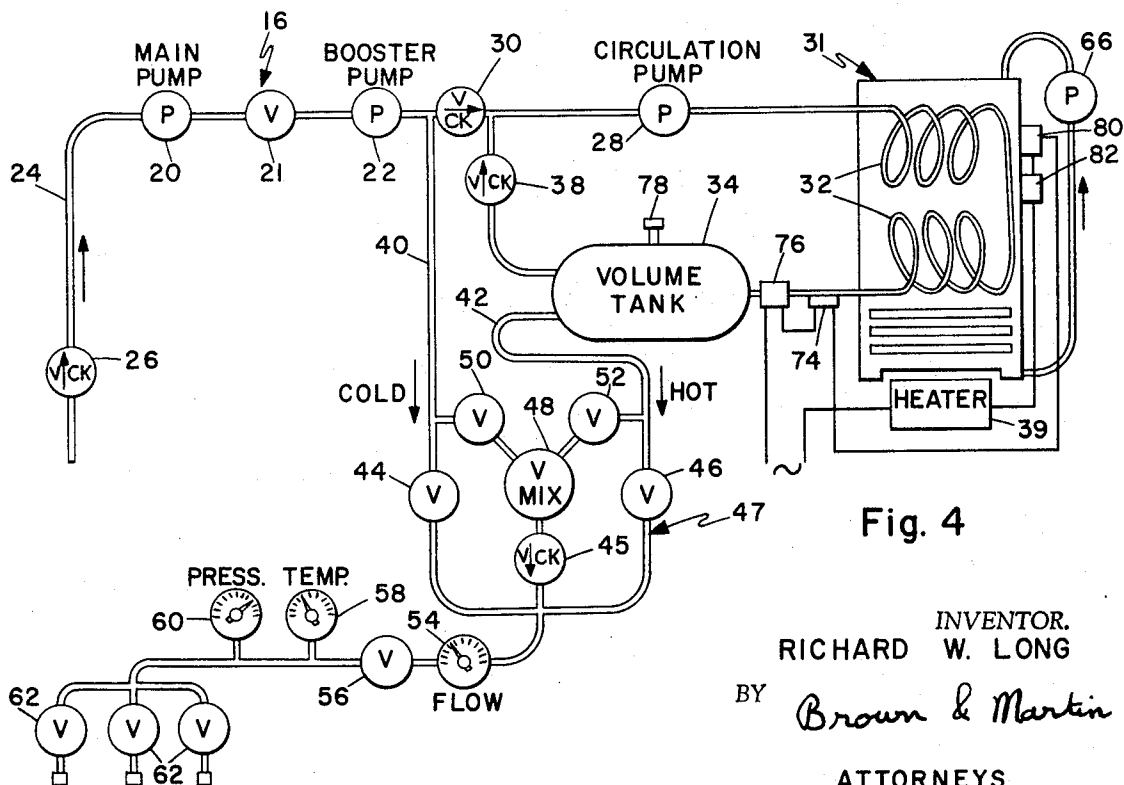


Fig. 4

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HOT WATER HEATER SYSTEM FOR DIVERS

BACKGROUND OF THE INVENTION

Divers working in cold water must be provided with some means, beyond merely insulated suits, of maintaining their body temperature. Heated hot water suits have been provided for this purpose wherein the divers are connected by a hose to a source of hot water on the surface or at another location spaced from the diver. Such hot water heaters are subjected to an unusually severe environment and rough usage and yet must dependably provide heated water of the proper temperature and volume to maintain a divers body temperature at a comfortable level. Prior art heater systems have not provided adequately for security of operation and have been prone to failure at critical times. Some prior art devices have employed electrical sensors and electrically operated valves to protect the various components in the heater system from damage. These electrical devices are subject to failure in harsh environment and thus frequently fail to function as required.

An additional defect of prior art systems was their inability to maintain readiness to deliver water of the correct temperature over long periods of time. A further defect of prior art systems was the possibility of damage by inadvertent improper actuation of the controls.

It would therefore be advantageous if a hot water heater system could be provided that would dependably deliver water of the proper temperature and volume to one or several divers with a considerably reduced likelihood of failure and ability to withstand rough and improper usage.

SUMMARY OF THE INVENTION

An exemplary embodiment of the invention provide a hot water heater system for divers which is suited for shipboard use and includes its own heat source so as to be dependent on ship services for electrical power only. The system is suitable for use in the corrosive salt water environment and employs a design which minimizes the possibility of damage due to inadvertent improper operation.

The system utilizes three main sub-systems including a water supply system, a circulation system, and a heated water delivery system.

The supply system incorporates an intake conduit which has a foot valve at its terminal end so that the intake conduit can be immersed in a supply of water to be utilized, such as, the ocean. The purpose of the foot valve is to prevent backflow during standby periods so that the pumps need not be re-primed for continued operation. The pumps employed are of the centrifugal type so as to avoid problems associated with constant displacement pumps as, for example when the discharge valving is closed to produce a hard head. In the exemplary embodiment, two pumps are used, a main pump which is capable of drawing water against a considerable head and a booster pump to raise the pressure of the water delivered from the main pump to a sufficient value to maintain flow to the diver at great depths. The system will maintain a continued flow despite failure of either pump. The output of the supply system is available either to the circulation system or may be delivered through the discharge system by the operation of valving.

Water added by the supply system to the circulation system is provided through a conduit with a check

valve or other one-way valve which prevents the back-flow of water from the circulation system to the supply system or the discharge system. A volume of water is maintained circulating through the circulation system by a circulation pump. During periods when no flow is being utilized for heating the divers suits, the flow in the circulation system is from the circulation pump through the coils or other heat exchange conduits of a heat exchanger and then into a volume tank for returning to the circulation pump. The conduit between the volume tank and the circulation pump includes a check valve which prevents reverse flow and accordingly the water delivered from the volume tank to the discharge system will not cause a reduction in the water delivered to the circulation pump and the water from the supply system will always circulate first to the circulation pump. The volume tank has sufficient capacity so that should the demand for heated water increase suddenly, such as by the addition of an additional diver to the circuit, the temperature of the water discharged will not decrease drastically in the interim period while the thermostat in the heat exchanger adds additional heat from a source of heat to raise the amount of heat entering the system and therefore maintaining the temperature output relatively constant.

Temperature surge is also limited by the use of a high flow rate in the circulation system. This rate is in excess of the maximum rate at which rate is withdrawn and therefore water is maintained in circulation despite the demands of the discharge system.

A flow actuated switch permits power to the source of heat only if flow is maintained through the heat exchanger coils to prevent damage to the coils if the flow should cease.

Final control over the volume and temperature of the water discharged from the system and to the divers is maintained by mixing unheated water taken directly from the booster pump with the heated water from the circulation system. For this purpose the discharge system includes four control valves on both the heated and unheated sides of the inlets as well as a temperature indicator to provide a means for setting the final discharge temperature. The discharge system also includes a manifold to provide a flow to one or more divers.

An additional feature of the invention is an automatic temperature control system and the discharge system. The mixing valve utilizes a temperature sensitive element for varying the mixture between the heated and unheated water and discharges through a conduit that may contain volume, temperature and pressure indicators as well as a main flow control valve. Operational security is ensured by the provision of valves to isolate the automatic mixing valve and return to the manual mode should the automatic mixing valve fail, such as by an accumulation of scale or other foreign matter. Should manual operation become necessary the flow control valve together with the indications of volume flow, temperature, and pressure may be utilized to manually regulate the heat and volume of water reaching the divers.

A modified form of the invention incorporates an additional circulating cycle which enables the heat transfer from the heat source to the first fluid to be between the heat source and a fluid other than salt water for example, fresh water. This system isolates the salt water from direct contact with the surfaces heated by the

source of heat and thereby avoid its many of the limitations and inefficiencies of direct heated salt water. The most significant limitation of a direct heated hot water system, is that the system must be operated at a relatively low temperature to avoid an accumulation of deposits that tend to reduce the overall heat transfer and the efficiency of the system to an unacceptable degree after a relatively short period of time. In the modified embodiment of the invention the salt water is heated by boiler water much higher heat transfer efficiency then can be accomplished by heating the boiler water to temperatures of 200° or more and then using a secondary heat exchanger to transfer heat from the boiler water to the salt water.

The invention provides a system which by the inherent functioning of its design is immune from many of its failures to which other systems are subject. A failure of any of the pumps or an improper closing of any of the valves will not occasion the failure of any other piece of equipment within the system and the check valves which isolate one sub-system from the other also function to maintain the system in readiness for a quick transfer from a stand-by status to on line use. For example, if the supply system is turned off or the valves from the discharge system shut, the water within the circulation system will continue to circulate and the check valves will isolate the circulation system from the other sub-systems. The temperature control thermostat of the heat system will maintain the temperature of the water at an acceptable level so that when the demand for water returns, an adequate supply of hot water will be available, with no start up time being required.

It is therefore an object of the invention to provide a new and improved hot water heater system for divers.

It is another object of the invention to provide a new and improved method for heating water for divers.

It is another object of the invention to provide a new and improved hot water heater system which has increased protection against failure.

It is another object of the invention to provide a new and improved hot water heater system which reduces the temperature fluctuations caused by changes in the demand for heated water.

It is another object of the invention to provide a new and improved hot water heater system for divers which automatically regulates the temperature of the discharged heated water by mixing heated water with unheated water in the proper amounts.

It is another object of the invention to provide a new and improved hot water heater system for divers in which the heat from the source of heat is transferred to an intermediate fluid before being transferred to the water for delivery to the divers.

It is another object of the invention to provide a new and improved hot water heater system which is low in cost and simple in design.

It is another object of the invention to provide a new and improved hot water heater system for divers which is quick to return to full operation when placed in a standby status.

Other objects and many attendant advantages of this invention will be apparent from a reading of the specification together with the drawings in which like reference numerals refer to like parts throughout and in which:

FIG. 1 is a side elevation view of the heater system of the invention.

FIG. 2 is a side elevational view illustrating the placement of the invention on a vessel.

FIG. 3 is a schematic illustration of a form of the heater system of the invention.

FIG. 4 is a schematic illustration of a modified form of the invention.

Referring now to the drawings, there is illustrated the hot water heater system of the invention indicated generally at the numeral 10. In FIG. 1, the system is shown to be mounted on a skid 12 which includes lifting lugs 14. The system illustrated is that of FIG. 3 which in schematic form shows the configuration of the invention. The water supply system 16 includes a main pump 20 with a priming valve 21 supplying a booster pump 22. Water to the pumps is provided by an inlet conduit 24 which includes a foot valve or check valve 26. The inlet end of the conduit is immersed in a supply of water as will more clearly appear from FIG. 2.

The output of the supply system flows through a check valve 30 to the circulation system 18. The flow within the circulation system is maintained by a circulation pump 28 which circulates the water through coils 36 in a heat exchanger 37. The fluid is heated within the heat exchanger by conduction from the output of a burner 39. The output of heated water from the heat exchanger is received within a volume tank 34. If no water is leaving the system as during times when there are no diver requirements for heated water, the output of the volume tank recirculates through the circulation system by passing through check valve 38 and being reinserted in circulation pump 30. The volume tank is protected from overpressure and air accumulation by pop-off valve 78. A thermostat 74 maintains the temperature of the water in the circulation system at a preset level. If demand for the heated water increases, so as to cause unheated water to flow through check valve 30 into the circulation system, thereby lowering the temperature of the water within the system, the thermostat will activate the heat source 39 so as to raise the temperature of the water within the circulation system back to the preset level.

A flow switch 76 defeats the operation of the heater unless water is flowing through the exchanger coils.

A line 42 from the volume tank together with a line 40 which is connected to the output of the booster pump comprises the conduits for inputting the discharge system.

The discharge system illustrated generally by the numeral 47 includes both manual and automatic means for regulating the temperature delivered to the divers. The temperature of the water may be regulated in part through the use of a thermostat within the circulation system, but more immediate control is obtained by mixing cold and hot water in the discharge system. In this manner the temperature of the water delivered may be immediately lowered by increasing the amount of unheated water in proportion to heated water and the temperature may be raised by decreasing the amount of unheated water mixed with the heated water. This may be accomplished by varying the set point on an automatic mixing valve 48. The automatic mixing valve has a bulb extending into its output duct and responds to changes in temperature of the output water by varying the position of a piston. The piston valves the input of heated and unheated water to maintain a constant output. Since failure of the automatic mixing valve could produce unacceptable temperature levels for the

divers, means comprising valves 50 and 52 are provided to isolate the automatic valve from the system. With valves 50 and 52 closed, and valves 44 and 46 open, the entire flow of water will bypass the mixing valve and will be prevented from entering the discharge end of the automatic mixing valve by check valve 45. The temperature of the water output may then be manually regulated by varying the mixture between heated and unheated water through the use of valves 44 and 46. Since the quantity of heat delivered to the diver is dependent on the volume of flow as well as the temperature of the water, means including a valve 56 and a flow meter 54 are provided to monitor and vary the flow output of the system. Similarly the temperature output is monitored and may be varied in the manual mode of operation through the use of the temperature gauge 58. Further monitoring of the system is obtained by the use of a pressure gauge 60, that provides early indication of system malfunction. The discharge system provides for a plurality of divers and in the illustrated embodiment, three ball valves 62 are provided so as to provide on-off control for up to three divers.

The use of the system with two divers is illustrated in FIG. 2 which represents two discharge hoses 68 being connected to two divers 69. FIG. 2 also illustrates the location of the heating system 10 on the deck of a surface vessel 70 with the inlet conduit 24 being immersed below the surface of the ocean. Referring now to FIG. 4, there is illustrated a modified form of the invention which employs supply system 16 and discharge system 47 identical to that of FIG. 3 but incorporating a modified circulation and heat transfer system 31. The heat transfer system utilizes an intermediate fluid circulating within the induction range of the heat source 39 under the influence of a boiler circulating pump 66. The fluid is brought in heat exchange relationship to the water in the circulation system. In the illustrated embodiment, this is accomplished by a plurality of coils 32. A high level sensing switch 80 and a low level sensing switch 82 are connected in series in the heater and thermostat circuit to deactivate the system when either limit is exceeded.

In operation the system would be activated by placing the foot valve and conduit in the ocean below the surface a sufficient distance to avoid the lower end being raised above the surface during swells. The main pump is turned on and flow initiated by adding water through the priming valve as necessary. The booster pump would be turned on at this time also. The circulation system is filled by the action of the pumps. Air in the volume tank escapes from the top of the tank

through pop-off valve 78. Flow in the circulation system is initiated to permit the activation of the burner by the closing of flow control switch 76. The heat source then raises the temperature of the water circulating in the system to the temperature preset on thermostat 74.

It would then be possible to open any of the divers supply valves 62 and allow flow comprised of a mixture of a heated and unheated water to pass into the supply hose 68. The temperature of the water delivered to the diver is regulated through the use of the automatic mixing valve which may be set to a desired temperature. Alternatively the automatic mixing valve may be isolated from the system and the manual valves employed to provide a mixture of heated and unheated water to produce the proper temperature, as would be indicated on the temperature gauge 58. The flow control valve would be employed to provide the proper flow depending on the number of divers using the system, for example, a single diver might require a flow of two gallons per minute and with a single diver utilizing the system the flow control valve would be varied to achieve that flow indication. If at a later time a second diver began to utilize the system, then it would be necessary to operate the flow control valve to obtain a total flow of four gallons per minutes so that each diver would continue to require the two gallons per minutes necessary.

Having described my invention I now claim:

1. A system for delivering heated water to divers comprising,
 - a circulation system including a source of heat means for transferring at least a portion of said heat to the water in said circulation system,
 - a supply system including means for pumping water from a source of unheated water,
 - means for delivery of said unheated water to said circulation system,
 - a heated water delivery system including means for transferring the water in said circulation system to a diver,
 - said heated water delivery system including automatic mixing means for adding a variable quantity of unheated water to maintain a constant temperature output of heated water despite variations in the flow of water to said divers, and
 - said heated water delivery system including means for connecting said automatic mixing means from said system and controlling the addition of unheated water manually.

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