

[54] HYPOTHERMIA SYSTEM

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[76] Inventor: Robert C. Miley, 2712 Roseland Ave., East Lansing, Mich. 48823

Primary Examiner—Lawrence W. Trapp
Attorney, Agent, or Firm—Malcolm R. McKinnon

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[56] References Cited

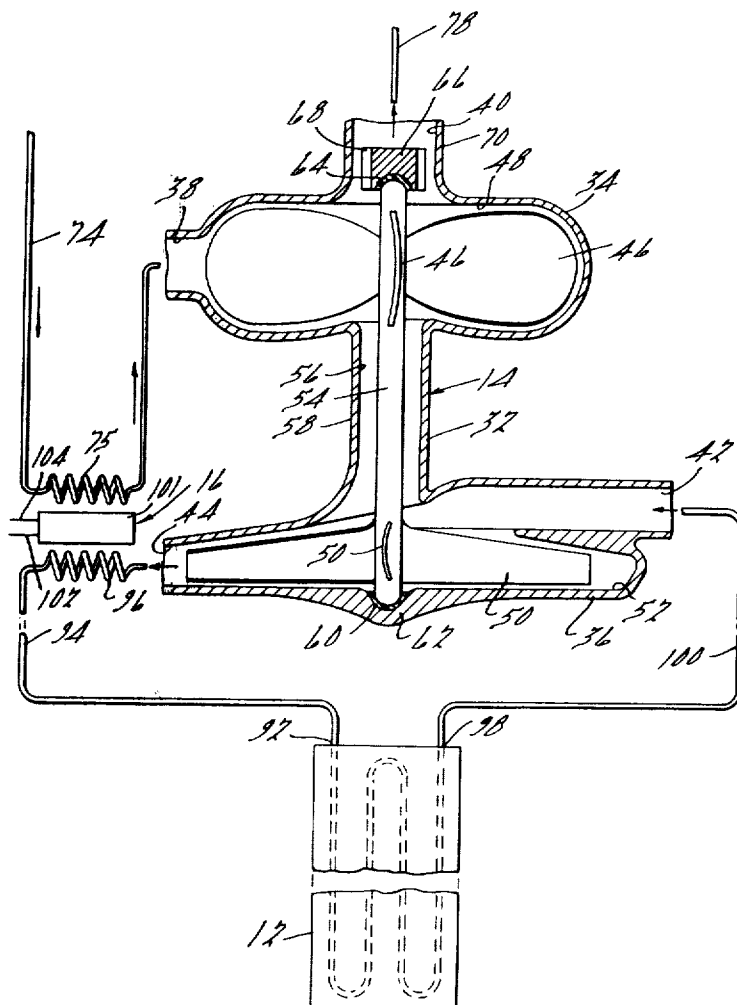
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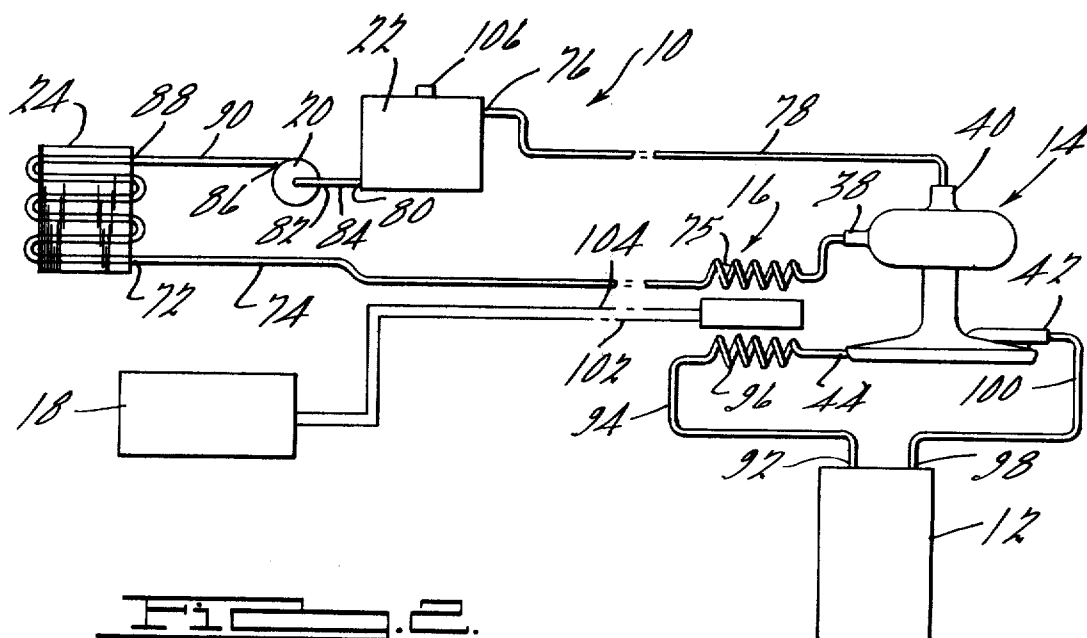
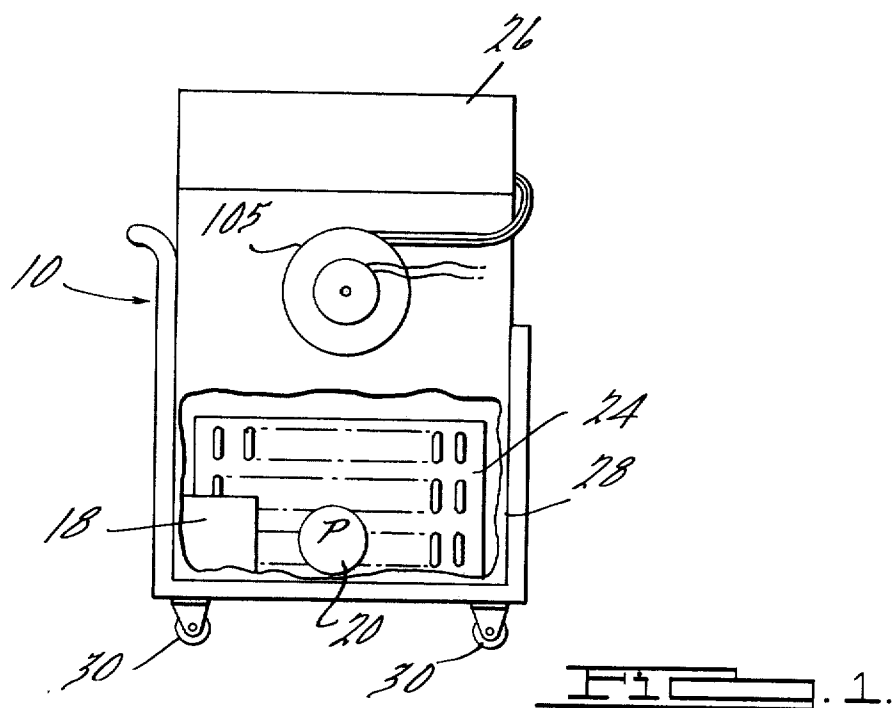
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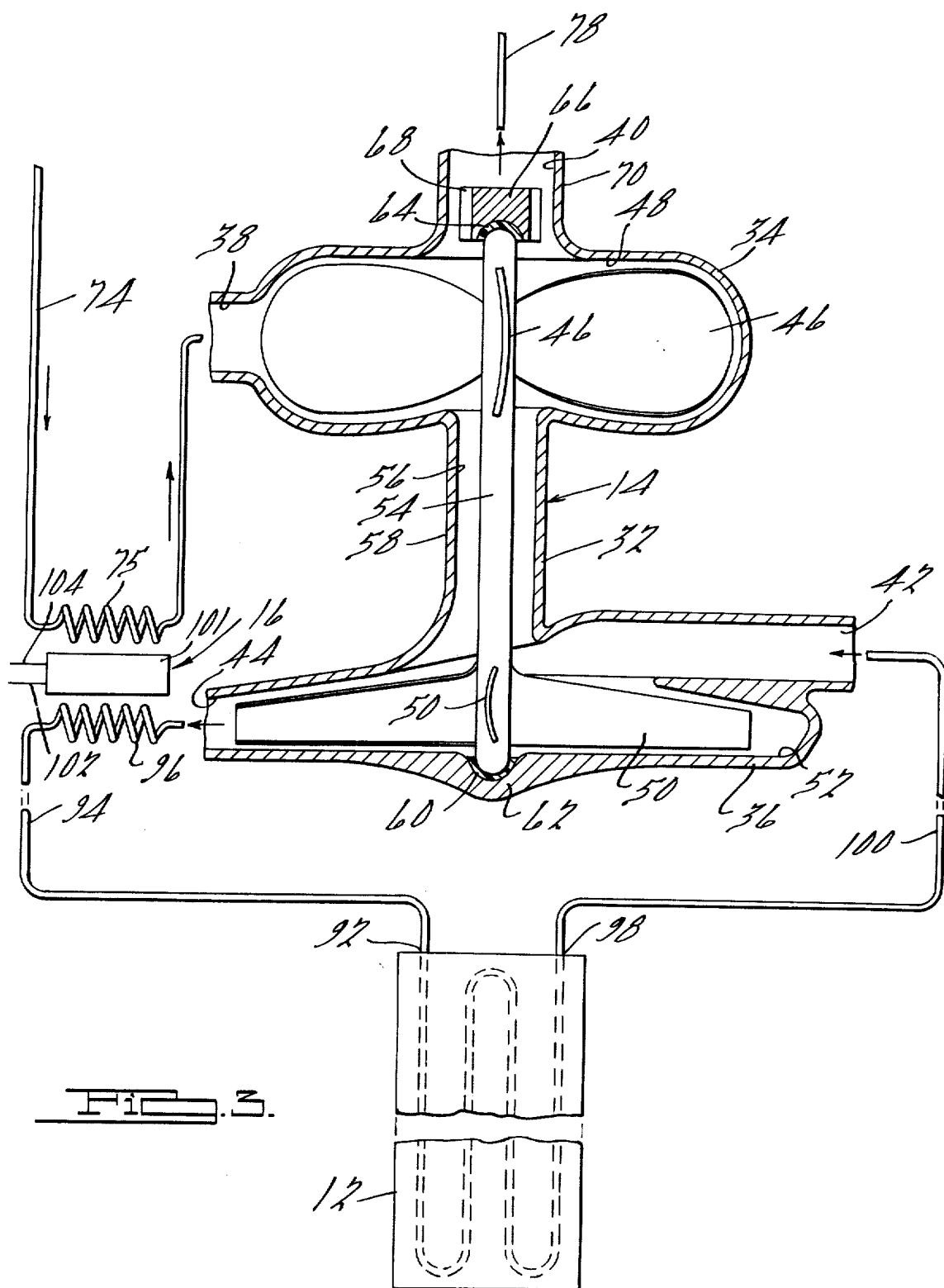
[57] ABSTRACT

A hypothermia system for therapeutic use, particularly in hospitals, to cool or heat patients, the hypothermia system including a novel fluid pressure operated impeller driven pump effective to recirculate heat transfer fluid through a virtually closed fluid circuit including a hypothermia pad.

14 Claims, 3 Drawing Figures







HYPOTHERMIA SYSTEM

BRIEF SUMMARY OF THE INVENTION

This invention relates to hypothermia systems and, more particularly, to an improved hypothermia system particularly adapted for use to cool or heat patients. Heretofore, various therapeutic systems have been employed to cool or heat patients, such prior therapeutic systems including relatively complex fluid systems incorporating hypothermia pads or the like through which a heat transfer fluid is circulated by means of pumps usually driven by electric motors. Such prior systems are relatively complicated and expensive, subject to excessive heat losses, often difficult to transport and require complex fluid circuitry which is difficult to install and maintain.

An object of the present invention is to overcome disadvantages in prior therapeutic systems of the indicated character and to provide an improved hypothermia system incorporating improved means for recirculating heat transfer fluid through a hypothermia pad to cool or heat patients.

Another object of the invention is to provide an improved hypothermia system for cooling or heating patients for medical purposes, which system incorporates improved fluid pressure operated impeller-pump means effective to recirculate heat transfer fluid through a virtually closed fluid circuit including a hypothermia pad.

Another object of the invention is to provide an improved fluid pressure operated impeller-pump particularly adapted for use in hypothermia systems.

Another object of the invention is to provide an improved hypothermia system that is relatively simple in construction, economical and commercially feasible to manufacture, assemble and maintain, durable, efficient, reliable and quiet in operation and suited for explosion proof environments such as operating room or oxygen enriched atmospheres. The above as well as other objects and advantages of the present invention will become apparent from the following description, the appended claims and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevational view of a portable hypothermia system embodying the present invention;

FIG. 2 is a schematic view, with portions broken away, of the hypothermia system illustrated in FIG. 1; and

FIG. 3 is a sectional, elevational view of a fluid pressure operated impeller-pump embodying the present invention, showing the same installed in the hypothermia system illustrated in FIGS. 1 and 2.

DETAILED DESCRIPTION

Referring to the drawings, a hypothermia system, generally designated 10, is illustrated embodying the present invention, the hypothermia system 10 being adapted for use, particularly in hospitals, to cool or heat patients for medical purposes. In the preferred embodiment of the invention illustrated, the hypothermia system 10 includes a conventional hypothermia pad 12 through which a heat transfer fluid, such as water, is circulated to cool or heat patients who have been placed in contact with or wrapped in the pad 12. The hypothermia system 10 also includes a fluid pressure operated impeller-pump, generally designated 14,

which will be described hereinafter in greater detail, and a conventional thermo-electric heating-cooling unit, generally designated 16, effective to cool or heat water or other fluid circulating through the hypothermia pad 12. The hypothermia system also includes a D.C. power supply 18, an electric motor driven pump 20, a fluid reservoir 22 and a convective heat exchanger 24. As illustrated in FIG. 1, the fluid pressure operated impeller-pump 14 and the thermoelectric heating-cooling unit 16 are preferably mounted in a removable compartment 26 carried by a base compartment 28 mounted on casters 30. The D.C. power supply 18, electric motor driven pump 20, fluid reservoir 22 and convective heat exchanger 24 are preferably mounted in the base compartment 28 although it will be understood that, if desired, the power supply 18, pump 20, reservoir 22 and heat exchanger 24 may be permanently installed in a convenient location.

In the embodiment of the invention illustrated, the impeller-pump 14 is comprised of a housing 32 defining an upper impeller portion 34 and a lower pump portion 36 disposed below the impeller portion 34, the impeller portion 34 including a fluid inlet 38 and a fluid outlet 40 while the pump portion includes a fluid inlet 42 and a fluid outlet 44. A plurality of conventional curved impeller blades 46 are provided which are disposed in an impeller chamber 48 defined by the upper impeller portion 34 of the housing 32, and a plurality of conventional curved pump blades 50 are provided which are disposed in the pump chamber 52 defined by the lower pump portion 36 of the housing 32. The impeller blades 46 and the pump blades 50 are mounted on a common shaft extending through a passageway 56 defined by the central portion 58 of the housing 32. The lower end of the shaft 54 is supported by a bearing 60 carried by the lower end wall 62 of the housing 32 while the upper end of the shaft 54 is supported by a bearing 64 carried by a spider 66 having circumferentially spaced, angularly disposed legs 68 fixed to the wall portion 70 of the housing defining the outlet 40.

In the illustrated embodiment of the invention, the inlet 38 of the impeller portion 34 is connected to a source of pressurized water, such as the outlet 72 of the heat exchanger 24, by a conduit or hose 74, one side 75 of the thermoelectric heating-cooling unit 16 being interposed between the hose 74 and the inlet 38 of the impeller portion 34. The outlet 40 of the impeller portion 34 is connected to the inlet 76 of the reservoir 22 by a conduit or hose 78, while the outlet 80 of the reservoir 22 is connected to the inlet 82 of the pump 20 by a conduit 84, the outlet 86 of the pump being connected to the inlet 88 of the heat exchanger 24 by a conduit 90.

In the embodiment of the invention illustrated, the outlet 44 of the pump portion 36 is connected to the inlet 92 of the hypothermia pad 12 by a conduit or hose 94, the other side 96 of the thermoelectric heating-cooling unit 16 being interposed between the outlet 44 of the pump portion 36 and the inlet 92 of the hypothermia pad 12. The outlet 98 of the hypothermia pad 12 is connected to the inlet 42 of the pump portion 36 by a conduit or hose 100.

The thermoelectric heating-cooling unit 16 is a conventional low current, D.C. module which may be obtained, for example, from Materials Electronic Products Corporation, Trenton, N.J. 08638, the thermoelectric material 101 being comprised of a quaternary

alloy of bismuth, tellurium, selenium, and antimony with small amounts of suitable dopents, processed to produce an oriented polycrystalline ingot with anisotropic thermoelectric properties. The thermoelectric material 101 of the unit 16 is connected to the D.C. power supply 18 by conductors 102 and 104. Depending upon the direction of flow of the D.C. current, one side of the unit 16, such as the side 75, becomes hot when D.C. current is applied to the thermoelectric material of the unit 16 while at the same time the other side 96 of the thermoelectric unit becomes cold. When the flow of D.C. current is reversed, the side 75 becomes cold while the side 96 becomes hot as will be readily understood by those skilled in the art.

The connective heat exchanger 24 may, for example, be of the type conventionally utilized as an evaporator in household or commercial refrigerators and is preferably formed with flat, smooth exterior surfaces and built in coils, the exterior surfaces thus being devoid of fins (which would tend to collect dirt, dust, bacteria and other foreign materials). With such a construction, the heat exchanger 24 may be easily cleaned and sterilized and since forced air cooling and fins are not utilized, the heat exchanger may be easily maintained in a sterile condition by hospital personnel. The heat exchanger 24 as well as the power supply 18 are preferably mounted in the lower compartment 28 and may be disposed at a position remote from the patient when the hypothermia system is in use while the removable compartment 26 containing the heating-cooling unit 16 and the impeller-pump 14 are disposed near the patient. As shown in FIG. 1 of the drawings, the fluid conduits 74 and 78 and the electrical conduits 102 and 104 are preferably mounted on a drum 105 secured to the lower unit whereby the fluid conduits 74 and 78, the electrical conduits 102 and 104 and the removable compartment 26 may be extended from the base unit 28 when the system is in use and retracted when the system is not in use.

In the operation of the hypothermia system 10, assuming that it is desired to cool a patient who has previously been placed in contact with the pad 12, and further assuming that the system is substantially filled with a heat exchange fluid such as water, the D.C. power supply 18 and the pump 20 are first energized. The current flowing through the thermoelectric heating-cooling unit 16 then causes the side 75 to become warm and the side 96 to become cold. At the same time, pressurized water flows from the outlet 86 of the pump 20, through the conduit 90, the heat exchange unit 24 and through the pipe 74 and the warm side 75 of the thermoelectric cooling unit 16 to the inlet 38 of the impeller portion 34. The incoming pressurized water then flows through the chamber 48, down through the passageway 56 surrounding the shaft 54 and through the pump chamber 52 to the outlet 44. The incoming pressurized water then flows through the cool side 96 of the thermoelectric cooling unit 16, which cools the water, and through the pipe or hose 94 to the inlet 92 of the hypothermia pad 12 so as to cool the patient. The water flows through the outlet 98 of the hypothermia pad 12, through the hose 100 to the inlet 42 of the pump portion 36 of the impeller-pump 14. Any air entrained in the system is vented through the passageway 56 and out through the outlet 40 of the impeller portion 34, such air subsequently being vented to the atmosphere from the open vent 106 in the reser-

voir 22. As soon as the system is completely full of water and all air has been evacuated from the system through the outlet 40 of the impeller portion 34, rotation of the impeller blades 46 is effected by virtue of the pressurized water entering through the inlet 38, impinging upon the impeller blades 46, and then flowing out through the outlet 40 of the impeller portion. Rotation of the impeller blades 46 effects rotation of the pump blades 50, carried by the common shaft 54, to pressurize the water in the pump chamber 52 at a somewhat lower pressure than the pressure of the incoming water at the inlet 38 of the impeller, and the pump portion consequently initiates circulation of cool water from the outlet 44, through the cool side 96 of the thermoelectric unit 16, through the hypothermia pad 12, and back to the inlet 42 of the pump portion 36. Such a system permits a virtual closed circuit loop for recirculation of cool water through the hypothermia pad 12 so as to increase the efficiency but allows communication with a remote pressurized water source. The lack of a substantial pressure differential between the chambers 48 and 52 prevents substantial mixing of the incoming pressurized water with the cool recirculating water with the result that substantial isolation of the two fluid loops is established.

When it is desired to heat the patient, the flow of D.C. current from the power supply 18 is reversed so that the side 75 of the thermoelectric unit 16 becomes cool while the side 96 becomes hot. Water emanating from the heat exchange unit 24 then flows through the system in the manner previously described whereby heated water flows through the hypothermia pad 12 to heat the patient while relatively cool water flows through the impeller pump portion 14 as previously described. The heat exchange unit 24 thus serves to cool the recirculating water when the system is utilized to cool a patient and the heat exchange unit 24 serves to raise the temperature of the water circulating through the impeller-pump unit 14 when the hypothermia system is utilized to heat a patient.

From the foregoing description, it will be appreciated that the upper removable compartment 26 may be conveniently disposed at the bedside of the patient, the impeller-pump portion and the thermoelectric unit 16 being disposed in such compartment and operating with relatively little noise while the base unit 28 may be disposed at a distance remote from the patient whereby any noise emanating from the pump 20 will be muted so that the patient is not unduly disturbed. At the same time, since the thermoelectric unit 16, in use, is situated relatively close to the patient, heat losses between the thermoelectric unit 16 and the hypothermia pad 12 through the hoses 94 and 100 are reduced to a minimum. Moreover, no additional spark insulation is required, with the result that the hypothermia system is eminently suited for explosion proof environments such as operating rooms and oxygen enriched atmospheres.

While a preferred embodiment of the invention has been illustrated and described, it will be understood that various changes and modification may be made without departing from the spirit of the invention.

What is claimed is:

1. In a hypothermia system, the combination including hypothermia pad means, fluid heat exchange means, fluid pressure operated impeller-pump means having an impeller portion and a pump portion each

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provided with a fluid inlet and a fluid outlet, a source of fluid pressure, means for connecting the inlet of said impeller portion to said source of fluid pressure, and a closed fluid circuit connecting the outlet of said pump portion to the inlet of said pump portion through said heat exchange means and said hypothermia pad means, said source of fluid pressure comprising a second closed fluid circuit including the outlet of said impeller portion and second heat exchange means.

2. In a hypothermia system, the combination including hypothermia pad means, fluid heat exchange means, fluid pressure operated impeller-pump means having an impeller portion and a pump portion each provided with a fluid inlet and a fluid outlet, a source of fluid pressure, means for connecting the inlet of said impeller portion to said source of fluid pressure, and a closed fluid circuit connecting the outlet of said pump portion to the inlet of said pump portion through said heat exchange means and said hypothermia pad means, said impeller-pump means including a housing defining an impeller chamber and a pump chamber, a shaft carried by said housing and extending into said impeller chamber and said pump chamber, a plurality of impeller blades disposed in said impeller chamber and fixed to said shaft, and a plurality of pump blades disposed in said pump chamber and fixed to said shaft.

3. The combination as set forth in claim 2 including a fluid passage connecting said impeller chamber with said pump chamber.

4. The combination as set forth in claim 3 wherein said shaft extends through the fluid passage connecting said impeller chamber with said pump chamber.

5. In a hypothermia system, the combination including hypothermia pad means, fluid heat exchange means, fluid pressure operated impeller-pump means having an impeller portion and a pump portion each provided with a fluid inlet and a fluid outlet, a source of fluid pressure, means for connecting the inlet of said impeller portion to said source of fluid pressure, and a closed fluid circuit connecting the outlet of said pump portion to the inlet of said pump portion through said heat exchange means and said hypothermia pad means, said source of fluid pressure comprising electric motor driven pump means and convective heat exchange means disposed in a second closed fluid circuit including the fluid inlet and the fluid outlet of said impeller portion.

6. The combination as set forth in claim 5 wherein said second closed fluid circuit includes a fluid reservoir and is vented to atmosphere.

7. In a hypothermia system, the combination includ-

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ing hypothermia pad means, fluid heat exchange means, fluid pressure operated impeller-pump means having an impeller portion and a pump portion each provided with a fluid inlet and fluid outlet, a source of fluid pressure, means for connecting the inlet of said impeller portion to said source of fluid pressure, and a closed fluid circuit connecting the outlet of said pump portion to the inlet of said pump portion through said heat exchange means and said hypothermia pad means, said fluid heat exchange means including a thermoelectric heating-cooling unit, a D.C. power supply, and means electrically connecting said power supply to said thermoelectric heating-cooling unit.

8. In a hypothermia system, the combination including hypothermia pad means, the thermoelectric heat exchange means, fluid pressure operated impeller-pump means having an impeller portion and a pump portion each provided with a fluid inlet and a fluid outlet, a first fluid circuit connecting the outlet of said pump portion to the inlet of said pump portion through said thermoelectric heat exchange means and said hypothermia pad means, fluid pump means, and a second fluid circuit connecting the outlet of said impeller portion to the inlet of said impeller portion through said fluid pump means.

9. The combination as set forth in claim 8 wherein said second fluid circuit includes convective heat exchange means.

10. The combination as set forth in claim 9 wherein said impeller-pump means includes a housing defining an impeller chamber and a pump chamber, a shaft carried by said housing and extending into said impeller chamber and said pump chamber, a plurality of impeller blades disposed in said impeller chamber and fixed to said shaft, and a plurality of pump blades disposed in said pump chamber and fixed to said shaft.

11. The combination as set forth in claim 10 including a fluid passage connecting said impeller chamber with said pump chamber.

12. The combination as set forth in claim 11 wherein said shaft extends through the fluid passage connecting said impeller chamber with said pump chamber.

13. The combination as set forth in claim 12 including a D.C. power supply, and means electrically connecting said power supply to said thermoelectric heat exchange means.

14. The combination set forth in claim 13 wherein said second fluid circuit includes a fluid reservoir and is vented to atmosphere.

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