June 17, 1969 R. W. LONG 3,449,761

HEATED UNDERWATER DIVING SUIT

Filed April 17, 1967 Sheet 1 of 2

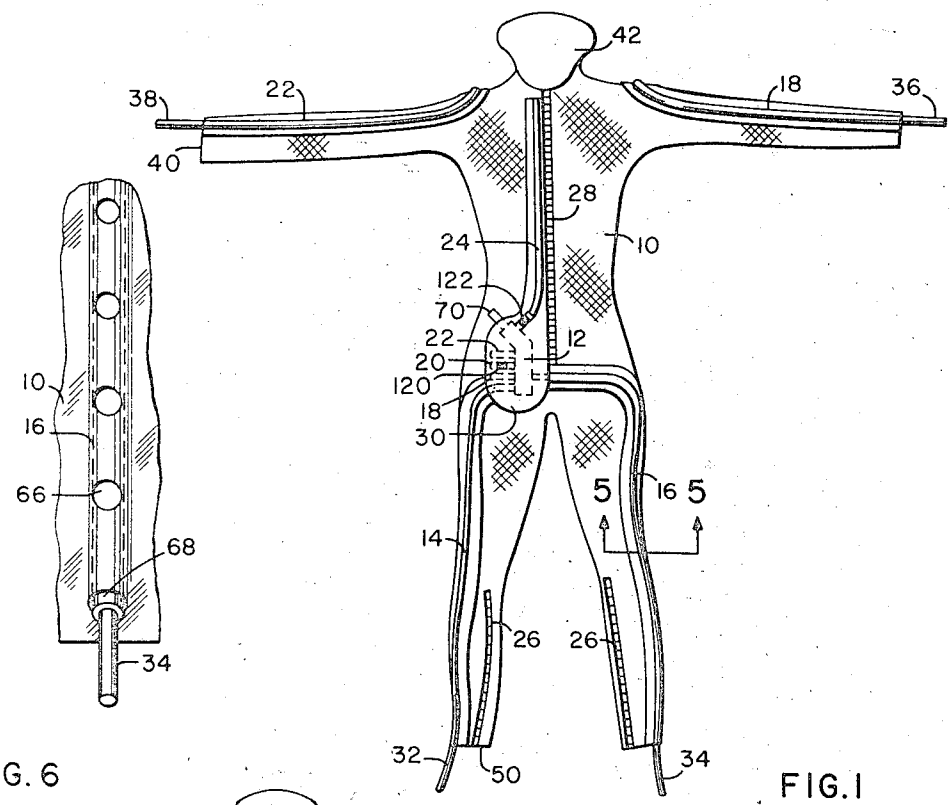

FIG. 1

FIG. 6

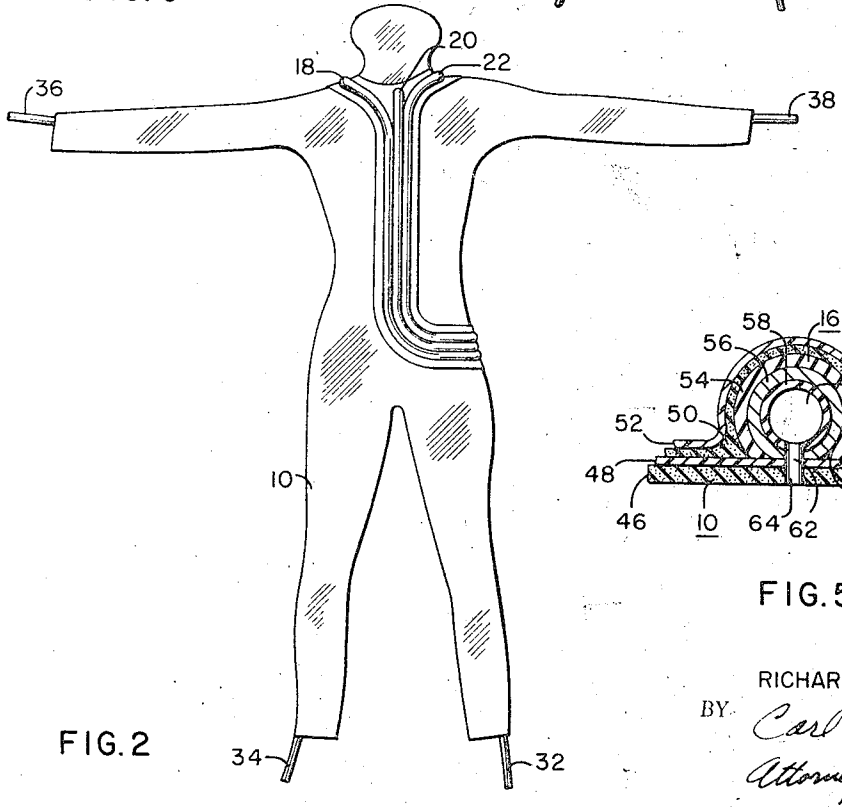

FIG. 2

FIG. 5

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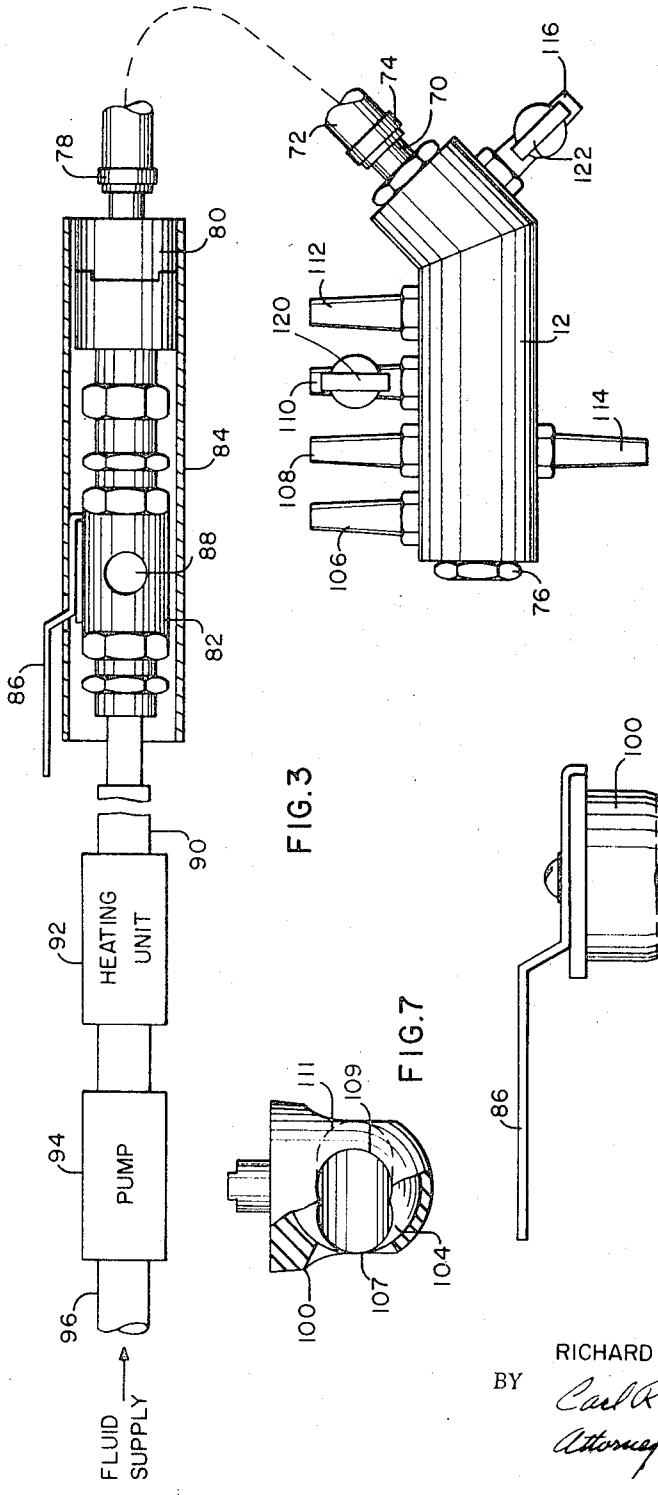

FIG. 3

FIG. 7

FIG. 4

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HEATED UNDERWATER DIVING SUIT

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U.S. Cl. 2—2.1 12 Claims

ABSTRACT OF THE DISCLOSURE

This invention relates to a heated underwater diving suit for receiving temperature controlled fluid under pressure which fluid is distributed through a plurality of conduits covering the diving suit. The conduits and suit have a plurality of matching holes through which the liquid passes supplying a uniform distribution of temperature controlled fluid to the cavity of the diving suit and out the neck, wrist and ankle openings.

BACKGROUND OF THE INVENTION

It is well known that the length of time a diver can work in cold water in known diving suits is limited. The cold water acts as an infinite heat sink that quickly draws the body heat from the diver. While diving suits have been developed to keep the diver warm when operating at depths in cold water, these known diving suits have been uniformly unsuccessful in accomplishing this purpose for the desired periods of time. The known heated diving suits have taken many forms, such as the electrically heated diving suit, which suit requires expensive and bulky support equipment and also can be dangerous to the diver. Another approach has been to pump hot water under pressure to the diving suit. However, these known hot water supplied diving suits only provide water exhaust points at the hands and feet of the diver and eject the water at such high temperatures near the wrist and ankles of the divers that the divers are often scalded by the hot water. These known hot water diving suits only deliver water to the divers hands and feet and do not provide overall uniform heat to the diver. Thus it is desirable to have a diving suit utilizing temperature controlled fluid to control the temperature of the environment of the diver under water and that provides a uniform distribution of the temperature controlled fluid over the divers entire body.

SUMMARY OF THE INVENTION

The diving suit of this invention covers the torso of the diver including his arms and legs. The suit may be of any construction known in the art, such as suits made of neoprene that is nylon lined. The diving suit is supplied with a temperature controlled fluid, usually water, under pressure through a tube that is connected to a heater and pump unit on the surface of the body of water. The supply tube is connected to a manifold that is secured to the diving suit near the hip of the diver. The manifold in turn supplies water to a plurality of conduits that are secured to the outer surface of the suit and cover the suit in a manner that distributes the water thereto in a substantially uniform distribution. The conduits have a plurality of spaced holes along their lengths that communicate with aligned apertures through the wall of the suit to inject water into the cavity of the suit. These lines run along the legs and arms of the suit and also up the front and back of the suit. The conduits terminate in open ended tubes at the wrists for providing the temperature controlled fluid to the gloves worn by the diver to heat his hands. The conduits along the legs terminate in open ended tubes that provide heated water to the boots of the diver for heating his feet.

The manifold has a pair of fluid control valves for controlling the flow of fluid in a conduit leading up the front and back of the diving suit. Also there is provided a second fluid control valve that controls the flow of fluid to the manifold in a manner that the diver may either direct the fluid into the surrounding water or direct the fluid into the manifold or direct a division of the fluid to either place. So there is a constant outlet for the fluid supplied by the pump. The diver is thus able, by means of the two control units, to control the fluid supplied to the manifold and throughout the conduits, and to individually control the fluid to the conduits extending up the front and back of the suit.

The individual diameters of each of the spaced holes in the conduits are increased in size along the length of the conduit in a direction away from the manifold. Thus the amount of fluid ejected into the suit from each of the conduits is thus maintained uniform, notwithstanding line pressure drops along the length of the conduits. This provides a more uniform distribution of fluid at the desired temperature throughout the cavity of the suit. Since the fluid leaving the conduits generally passes out through the suit's openings in the legs, arms and around the neck, the fluid leaving the holes in the conduits near the manifold joins the fluid leaving holes farther from the manifold, and the increased volume of the fluid along the length of the conduit is maintained at a substantially uniform temperature distribution.

Accordingly, applicant's invention provides a diving suit having substantially uniform temperature control of the fluid distributed to all parts of the body of the diver. This allows use of lower temperature fluid that may be selectively varied in temperature to co-act with changes in body heat of the diver.

It is therefore an object of this invention to provide a new and improved heated underwater diving suit.

It is another object of this invention to provide a new and improved heated underwater diving suit in which temperature controlled fluid under pressure is substantially uniformly distributed throughout the inner cavity of the suit.

It is another object of this invention to provide a new and improved heated underwater diving suit that can effectively use a lower temperature fluid.

It is another object of this invention to provide a new and improved heated underwater diving suit that does not burn or injure the diver.

Other objects and advantages of this invention will become more apparent upon reading the following detailed description and upon an inspection of the drawings wherein like reference numerals designate like parts throughout and in which:

FIGURE 1 is a front upright view of an embodiment of the diving suit of my invention.

FIGURE 2 is a back upright view of an embodiment of the diving suit of my invention.

FIGURE 3 is a schematic view illustrating the control unit for supplying temperature controlled fluid under pressure to the manifold on the diving suit.

FIGURE 4 is a side view of the ball valve used in the control unit.

FIGURE 5 is a cross sectional view taken along lines 5—5 of FIGURE 1.

FIGURE 6 is a broken away view of the inside surface of a part of one leg of the diving suit.

FIGURE 7 is a side view of the ball valve in the housing with parts broken away.

Referring now to FIGURE 1, there is illustrated an embodiment of the diving suit of this invention that may have a known wall construction such as for example, one-

fourth inch thick nylon lined neoprene. The nylon is on the outer surface and comprises a known nylon fabric. The suit is not water or fluid impervious. The suit is opened on its front side by a zipper **28** and zippers **26** on each leg allow the legs of the suit to be open for insertion of the feet of the diver. The leg ends of the suit **50** are open as are the wrist portions of the suit **40**. Thus fluid inside the suit may pass out through the openings around the feet and hands and also out the neck opening **42**.

The diver normally wears the suit under the water with a face mask, head gear or the like to which breathing gas is provided. A hose **90** carries temperature controlled fluid from the surface of the body of water to the suit. The temperature controlled fluid is supplied by pump **94** and heating unit **92**. A fluid supply provides fluid through line **96** to a pump **94**. The pump adds sufficient pressure to the fluid to provide the desired pressure to the suit at its location underneath the body of water. The heating unit **92** heats the fluid to the desired temperature. Hose **90** extends from the surface of the water to the diving suit and is connected to a second flow control means **82**. While the flow control valve **82** may have any known construction, the valve shown in the specific embodiment is a ball type valve having a control lever **86** and a side outlet port **88**. Ball valve housing **100** fits into the housing of valve **82** and has openings **102**, **103** and **105**. A ball valve member **104** has a passage **107** there-through that is cut out at one side **109** having a reduced in size section **111**. In operation the fluid can flow through passage **107** and through apertures **102** and **103** with a part of the fluid passing through opening **109** and out aligned openings **105** and **88**. When member **104** is rotated by lever **86**, then section **111** can close opening **105** and outlet port **88** providing full fluid flow through the valve **82**. A plurality of intermediate positions of the lever **88** allows water to flow jointly from conduit **90** to conduit **72** and out through the side aperture **88** in selectively controlled amounts. In a third position, the water then passes from conduit **90** out opening **88**. Thus the flow control means **82** is able to direct the fluid as desired without interrupting pressurized fluid flow from the pump **94**. Conduit **72** is connected by normal clamping means **74** and **78** to the flow control means **82** and to the manifold **12** through a connection **70**. Manifold **12** is a hollow manifold member having a closed end **76** and a plurality of outlet units **106**, **108**, **110**, **112**, **114** and **116**. The individual conduits on the diving suit **10** are individually connected to the outlet units as follows. Conduit **14** is connected to the outlet unit **106**, conduit **18** is connected to the outlet unit **108**, conduit **20** is connected to the outlet unit **110**, conduit **22** is connected to the outlet unit **112**, conduit **16** is connected to the outlet unit **114**, and conduit **24** is connected to the outlet unit **116**. The manifold **12** and all the outlet units **106**, **108**, **110**, **112**, **114** and **116** are secured to the suit **10** just above the groin area of the diver and to the right of center to keep the entire manifold **12** out of the divers way. A flap **30** of neoprene nylon lined, is cemented over the entire unit securing it to the suit and insulating the fluid therein from the outer ambient water. A similar neoprene covering **84** covers the control valve **82**.

As may be seen in FIGURE 1, the plurality of lines as previously described, are connected to the suit and are distributed over the area of the suit to provide an equal distribution of fluid within the cavity of the suit **10** in a manner to be described hereinafter. Referring to FIGURE 5, each conduit comprises an inner rubber lining **58**, having a woven braid layer **56** and an outer rubber layer **54**. One side of the conduit member **16** is shaved off giving a flat surface **57** that is glued or sealed to the outer surface of the suit **10**. An overlay of neoprene, nylon fabric lined, is layed over the top of the conduits with the edges sealed holding the conduits in their sealed position on the outer surface of the suit **10**. The conduit **16** has an aperture **62** therein that communicates with an opening **64** through the wall of the diving suit **10** through which the fluid or water passes from the conduit to the cavity of the suit. Holes **62** and **64** are spaced throughout the length of each of the tubes **14**, **16**, **18**, **20**, **22** and **24**. As is better illustrated in FIGURE 6, the inner surface of the suit **10** has a plurality of apertures **66** along the length thereof corresponding with spaced openings in the conduit, as for example conduit **16**, with the openings **66** having increasing diameters along its length away from the manifold **12**. At the bottom of the leg of the suit **10**, the conduit **16** projects through an opening and is connected by a nylon connector **68** to a flexible rubber tube **34** that projects into the boot (not shown) worn by the diver. Thus it may be seen that conduit **16** provides a distribution of fluid along the length of the leg cavity with the remaining fluid passing out through the opening of tube **34** in the boot worn by the diver. In the same manner, temperature controlled fluid is distributed in lines **20** and **24** to the torso portion of the suit **10** and through lines **18** and **22** along the arm portion of the suit with tubes **36** and **38** supplying the fluid to the gloves (not shown) worn by the diver.

The fluid passing out through the holes in the various conduits, expands the suit **10** and sheaths the diver with a film of fluid between the suit and the diver. This fluid passes out through the suit openings at the angles, wrists and neck of the diver. With the diameter of the conduit holes being smaller near the manifold **12**, it may be seen that substantially equal fluid volume is released to the suit at all points along the length of the conduit even though there are line pressure losses. Since the fluid normally forced out the holes adjacent, for example, the thigh of the diver will eventually pass out the opening **50** and in movement in that direction combines with the fluid that is also forced out the larger diameter holes closer to the diver's angle, it may be seen that a relatively uniform temperature distribution of the fluid is provided along the entire leg. The same applies to the fluid passing out through the neck opening **42** and out the wrist openings **40**.

Petcocks **120** in line **20** and **122** in line **24** permit the diver to control the flow of the temperature control fluid through these lines and thus adjust the temperature of the water or fluid adjacent the body of the diver within the diving suit **10**. The second flow control means **82** is normally connected within a foot of the diver for his close control.

In operation the fluid is heated on the surface of the body of water by heating unit **92** and is pumped through the system from a fluid source by pump **94** so that the fluid reaching the diver has a pressure of about 10 pounds per square inch. While the temperature of the fluid depends upon the depth of the diver, the temperature of the water in which he is diving, and the breathing gas used, it is generally desirable to have the temperature of the fluid around the diver at about 90 degrees, although in some circumstances the temperature can go up to 100 degrees Fahrenheit. Accordingly, the heating unit **92** heats the fluid so that it reaches the diver at about this temperature. It should be recognized that when the diver is working in a hot environment, such as in hot water, then the heating unit would be a cooling unit and cool fluid would be supplied to the suit **10**. The second fluid control means **82** is controlled by the diver operating lever **86** by which the diver can by-pass all or a part of the fluid, or deliver all or part of the incoming fluid to his suit **10**. The fluid reaching the manifold **12** is distributed through the various conduits and through the plurality of holes to the suit and to the gloves through tubes **36** and **38** and to the boots through tubes **32** and **34**. The diver by adjusting the fluid flow to his suit through the lever **86**, controls the temperature of the fluid around him in his suit. Petcocks **120** and **122** provide added control. The suit is loose fitting on the diver and balloons out when

receiving fluid so that the only points of contact with the diver are at the neck, wrists, and ankles.

It may be seen that the suit keeps the diver warm in cold water or cool in hot water by providing temperature control fluid to the diver. Thus even though the water surrounding the diver is an infinite heat sink, the diver is bathed in a sheath of fluid that insulates him from the surrounding water. An increased temperature of fluid covering the body surface is possible through my invention because the fluid is distributed to all parts of the body at substantially the same temperature. Thus a lower temperature fluid can be used that does not burn or injure the diver. The conduits run on the outside of the diving suit **10** and are not inside the suit where they could interfer with the diver in his work.

It is also contemplated that plugs or the like may be inserted in the ends of all the conduits creating back pressure that will force more fluid out the plurality of holes in the conduits and thus increase the fluid within the suit. In these situations the normal flow of fluid out the wrist openings **40** and the leg openings **50** and the opening around the neck **42** will be sufficient to keep the neck, hands and feet bathed in temperature controlled fluid and thus keep these extremities of the body at the desired temperatures.

Although I have illustrated and described a preferred form of my invention I contemplate that various changes and modifications can be made without departing from the invention, the scope of which is indicated by the following claims:

Having described my invention I now claim:

1. An underwater diving suit for receiving temperature controlled fluid under pressure through a tube comprising,
- a diving suit for covering the torso, arms and legs of a diver,
- conduit means for receiving said fluid and substantially uniformly distributing said fluid throughout the inner cavity of said diving suit and to the hands, feet and neck of the diver,
- said conduit means comprises a plurality of conduits distributed over said diving suit and fixed to said diving suit,
- said conduits having a plurality of holes at spaced intervals along the length thereof,
- said diving suit having a plurality of holes therethrough aligned with said holes in said conduits for passing fluid from said conduits to the inner cavity of said diving suit,
- certain of said conduits terminating with an open ended tube that is capable of projecting fluid to the hands and feet of the diver,
- a manifold for being attached to a tube from the pump to receive said fluid,
- said conduits being connected to said manifold for receiving said fluid,
- and said holes along the length of said conduits in a direction away from said manifold connection having increasing diameters.

2. An underwater diving suit as claimed in claim **1** in which,
- said conduits comprise individual lines extending from said manifold down each leg and along each arm, and up the front and back of said diving suit.

3. An underwater diving suit as claimed in claim **2** in which,
- said individual lines extending up the front and back of said diving suit have first valve control means operable by the diver for controlling the fluid flow in said lines.

4. An underwater diving suit as claimed in claim **3** in which,
- said manifold and said first valve control means are mounted on the front side of said diving suit just above the groin location of said diver and to one side.

5. An underwater diving suit that is capable of distributing temperature controlled fluid under pressure around a wearer comprising,
- a diving suit for covering the torso, arms and legs of a diver,
- said suit has a plurality of conduits distributed over the outer surface of the walls of said suit and along the arms and legs sections and are secured thereto,
- said conduits have a circular outer wall surface with a tangent section of the outer wall surface removed providing a flat surface that abuts against the outer surface of the walls of said suit,
- said conduits having a plurality of holes spaced along at least the length thereof adjacent the lower arms and legs and through said flat surface,
- and said diving suit has a plurality of holes therethrough aligned with said holes in said conduits for passing fluid from said conduits to the inner cavity of said diving suit.

6. An underwater diving suit as claimed in claim **5** including,
- a tube for carrying fluid in a given volume to said conduits from a pump unit,
- a valve positioned in said tube at a point adjacent said suit and having openings for passing fluid to said conduits and to the volume outside said suit,
- and said valve has means controlled by the wearer for selectively varying the fluid passing to said conduits and to said outside volume without decreasing the given volume fluid provided by the pump unit.

7. An underwater diving suit as claimed in claim **6** including,
- a manifold interconnecting said tube with each of said conduits,
- and ones of said conduits have second valve means operable by the wearer for selectively controlling fluid flow through said ones of said conduits.

8. An underwater diving suit as claimed in claim **5** including,
- a manifold for receiving fluid under pressure,
- one end of each of said conduits are connecting to said manifold,
- and said holes along the length of each of said conduits in a direction away from said manifold connection have increasing diameters.

9. An underwater diving suit as claimed in claim **5** in which,
- said leg and arm sections of said diving suit terminate at the feet and hands of the wearer,
- and said conduits extend beyond said termination for a sufficient length to project into gloves and boots worn by the wearer at points adjacent the fingers and toes.

10. An underwater diving suit that is capable of distributing temperature controlled fluid under pressure around a wearer comprising,
- a diving suit for covering the torso, arms and legs of a diver,
- said suit has a plurality of conduits distributed thereover and are secured thereto,
- means for opening said conduits at spaced intervals along the length thereof to the internal volume of the suit,
- a tube for carrying fluid in a given volume to said conduits from a pump unit,
- a valve positioned in said tube at a point adjacent said suit that has openings that pass fluid to said conduits and to the volume outside the suit,
- said valve has means controlled by the wearer for selectively varying the fluid passing to said conduits and to said outside volume without decreasing the given fluid volume provided by the pump unit,
- a manifold interconnecting said tube with each of said conduits,
- and ones of said conduits have second valve means operable by the wearer for selectively controlling fluid flow through said ones of said conduits.

11. An underwater diving suit that is capable of distributing temperature controlled fluid under pressure around a wearer comprising,

a diving suit for covering the torso, arms and legs of a diver,

said suit has a plurality of conduits distributed thereover and are secured thereto,

a manifold for being attached to a tube from the pump to receive the fluid,

said conduits are connected to said manifold for receiving said fluid,

means for opening said conduits at spaced intervals along the lengths thereof to the internal volume of the suit,

said opening means including a plurality of holes at spaced intervals along a length of said conduits,

and said holes along a length of said conduits in a direction away from said manifold connection having increasing diameters.

12. An underwater diving suit as claimed in claim 11 in which,

said leg and arm sections of said diving suit terminate at the feet and hands of the wearer,

and said conduits extend beyond said termination for a sufficient length to project into gloves and boots worn by the wearer at points adjacent the fingers and toes.

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