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Deloire et al.

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[54] **HEATING GARMENT**

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[52] **U.S. Cl.** **219/211,** 219/527, 219/529

[51] **Int. Cl.**.....**H05b 1/00**

[58] **Field of Search**.....219/54, 512, 527–529, 219/544, 552–553; 128/379, 402; 2/2.1 A

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[57] **ABSTRACT**

Heating garment intended for hindering little the wearer's movements and for uniformly distributing the warmth. Heating elements are placed inside passages made by sewing two fabrics the one with the other along parallel lines. The heating elements are not sewn to the fabrics but are maintained by the sewing lines. The form of the heating elements allows them to stretch.

13 Claims, 4 Drawing Figures

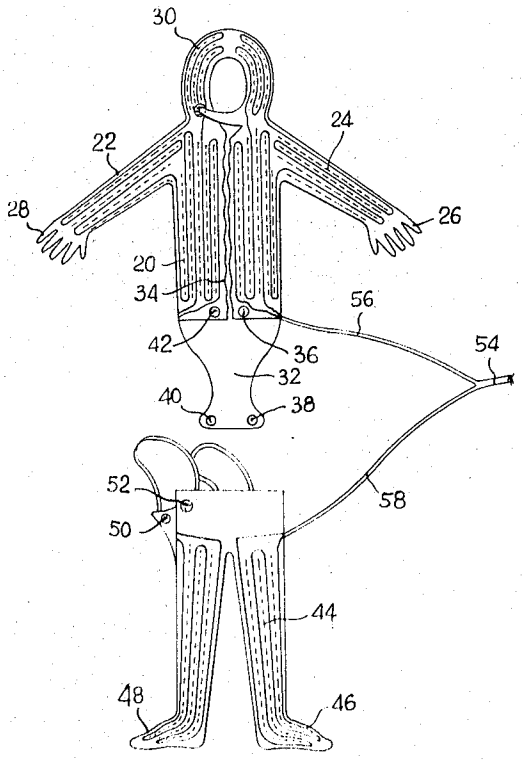


Fig.2

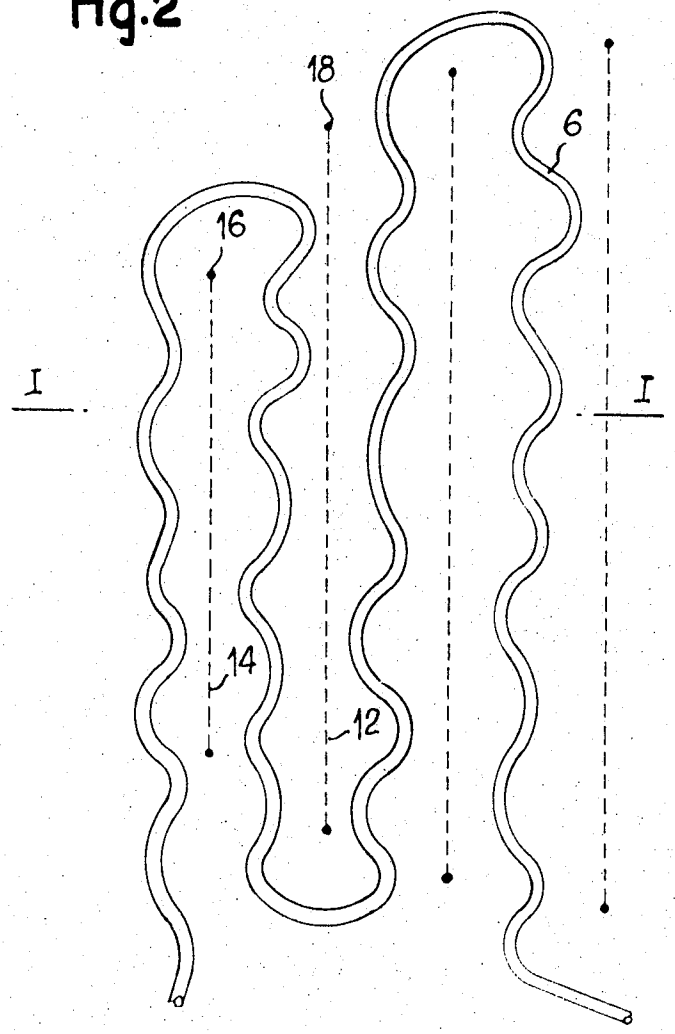
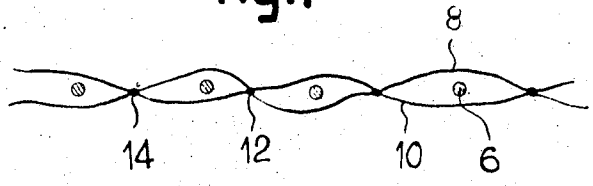


Fig.1



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Fig.3

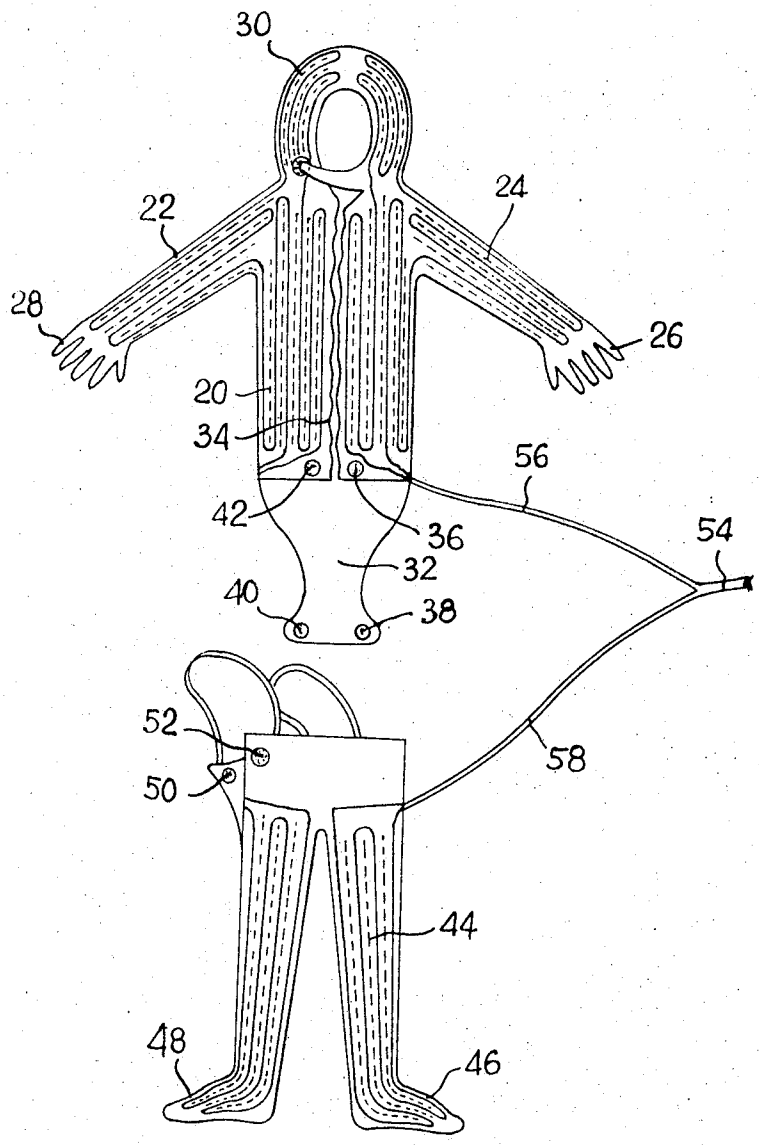
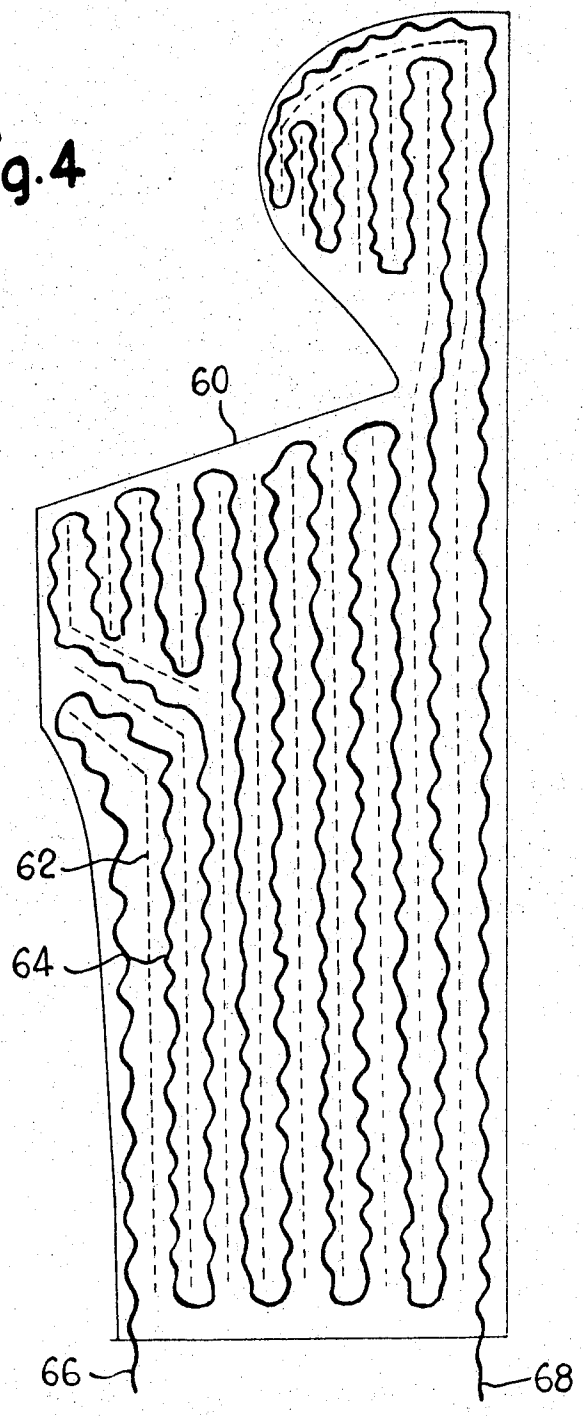


Fig. 4



HEATING GARMENT

The present invention relates to a heating garment, comprising conduits each of which contains one or more heating elements, the garment being made, at least in the zone thereof containing the heating elements, of a fabric which is extensible in at least one direction, and the heating elements being extensible at least over the greater portion of their length.

Heating garments are generally worn below a garment which is intended to provide insulation against the cold and frequently against an ambient medium ; they are worn for example for diving in extremely cold water and at considerable depth.

Such warming or heating garments may be manufactured from a fabric some of the filaments of which are constituted by a heating element, an electric wire or a tube through which there is a flow of hot water. However, these garments lack flexibility and are extremely costly to manufacture.

Heating or warming garments comprising conduits and to the fabric of which a heating element is sewn over the entire length thereof lack flexiblity in the direction of length of the heating element. Thus, they require to be custom made ; even in this case, they are difficult to put on, are uncomfortable and "in the long run" they fatigue the diver.

The garments according to the invention do not have these disadvantages. The heating elements, since they are flexible, impart in fact only a relatively low degree of stiffness which has practically no disturbing effect.

A garment according to the invention is characterized in that the heating elements are extensible, due to the fact that they have an undulated configuration in a plane parallel to the fabrics between which they are disposed, the developed length of a portion of the heating element being at least 1.5 times the length of its mean line, and due to the fact that the conduits are constituted by the assembly of two fabrics along lines, for example by sewing, sticking, or high-frequency welding.

Preferably, the heating elements are supported only by the said fabrics, by the said means for assembling the two fabrics and by the means which supply them with heating medium. With this mode of securing, the heating elements have a relatively considerable degree of freedom for displacement parallel to the fabrics, save at the points of connection to the feed source ; this prevents the setting up of local stresses in the said elements when the garment is subjected to the deformations which it is intended to undergo, for example when it is put on or removed or when the wearer bends over.

The heating element may be wound in helical form. In order to diminish the excess thickness which it produces, it is preferable to impart a generally flat shape to it.

The wire, filament, tube or the like constituting the heating element may be folded in a "broken" or crenellated line, the angles thereof may be rounded, or it may be folded in a sinuous line, etc.

The accompanying drawings show, diagrammatically and by way of non-limitative example, an embodiment of the invention utilizing an electrical heating system.

FIG. 1 shows, in cross-section taken along the line I—I of FIG. 2, a portion of the "heating" garment according to the invention,

FIG. 2 shows, in plan, the portion according to FIG. 1, the upper fabric being assumed to have been removed.

FIG. 3 shows a garment according to the invention.

FIG. 4 shows, drawn to a larger scale, the resistance wires and the seams of a portion of a garment.

FIGS. 1 and 2 show the heating element 6 which, in this case, is an electrical resistance wire, engaged between two fabrics 8,10 sewn along lines 12,14, to form conduits which are open at their ends.

The wire 6 is folded in accordance with a sinuous line and passes about the ends 16,18 of conduits, this, combined with the presence of the seams, being sufficient to prevent it from being displaced to any considerable degree. However, the wire enables the garment to be folded in all directions ; even if it were rectilinear, it would not hinder the stretching of the fabrics in the direction parallel to the line I—I ; in the direction perpendicular to the said line, its undulating shape would permit sufficient stretching. The seams are preferably arranged in a direction in which the garment will be required to change length at least when worn by a wearer and in which the fabrics are least extensible.

The fabrics 8, 10 are preferably extensible in all directions ; for example they may be jersey fabrics. The seams themselves have a certain degree of extensibility ; they could for example be manufactured with an appropriate stitch or they could be made from extensible wire. The distance between adjacent seams is relatively small, for example 2 cm , so that heating will be sufficiently uniform even if there is only a single heating wire per conduit ; this will also prevent local burning which might otherwise take place if the attempt were to be made to compensate for an excessively small length of wire by increasing the heat produced per centimeter of wire. The said fabrics are made for example from mixed filaments of substances which, under the influence of heat, carbonize without melting, the said mixture containing for example a high percentage of fibers of regenerated cellulose, viscose or rayon and a smaller percentage of the polyurethane elastomer fibers known as "Lycra" fibers.

The heating wire is for example a 1,6 or 13-strand wire made of a resistance alloy and covered by extrusion with a layer of polyvinyl chloride which will withstand a relatively high temperature, this being followed by a metallic braiding, which is preferably connected to the mass, whereupon follows a flexible insulating layer, made for example from the same polyvinyl chloride. The assembly has a diameter of approximately 2.5 mm. and may be folded readily and repeatedly.

The polyvinyl chloride may be replaced by some other electrically insulating, flexible material which also resists heat and the action of sea water, for example artificial rubber, silicone rubber, polytetrafluoroethylene.

The metallic braiding safeguards the diver in the case of a fault in the insulation means and distributes the heat produced more uniformly.

FIG. 3 shows a garment according to the invention, in two pieces, seen as a front view, one of the fabrics being assumed to be removed in order that the resistance wires may be visible. In order to render the drawing clearer, some of the heating elements of the seen face are not shown notably those relating to the

gloves, and the same applies to the seams between which they are lodged. For the same reason, the heating elements are shown in continuous lines, by means of their mean lines, without showing the small-amplitude sinuosities which make them extensible. The seams are shown in broken lines.

The garment shown comprises mainly a jacket and a pair of trousers.

The jacket comprises a jacket body **20**, sleeves **22,34**, gloves **26,28**, a hood or cowl **30** and a flap **32**. The jacket is closed by means of the sliding clasp fastener **34** and the flap is closed by the engagement, in pairs, of plates such as **36,38,40,42** one of which carries small hooks whereas the other carries small loops.

The pair of trousers **44** comprises shoes **46,48** ; it is closed by a paire of plates **50,52** having hooks and small loops. The upper portion of the trousers, covering the jacket, is not provided with heating elements and the same applies to the flap of the jacket.

The electric current may be direct or alternating. It may be obtained for example from a generator, an alternator, a battery of storage cells, a distribution network, etc. The current is supplied through a main cable **54** which divides into two secondary cables **56,58** having three conductors, one of which feeds the jacket whereas the other feeds the pair of trousers ; one of the three conductors connects the braids of the heating elements to earth.

Each of the secondary cables is continued at the level of the waist and feeds, in shunt, a plurality of resistance wires each of which heats a portion of the jacket or of the pair of trousers. The table given hereinbelow shows, by way of example, the various portions of a garment which has been manufactured, the number of wires per portion for the greater part of the portion, the wires of one and the same portion being connected in series, and also the power supply for a feed voltage of 24 volts.

Wires	Number of	Power
(Back and cowl) left-hand half	10+8	56 W
(Back and cowl) right-hand half	10+8	56 W
(Chest and stomach) left-hand half	11	46 W
(Chest and stomach) right-hand half	11	46 W
(Left-hand arm + forearm + hand)	14+12+5	42 W
(Right-hand arm + forearm + hand)	14+12+5	42 W
Left thigh	20	50 W
Right thigh	20	50 W
Left calf + foot	14+10	35 W
Right calf + foot	14+10	35 W

The total power, 458 W, may readily be modified by changing the feed voltage ; it is quadrupled if the voltage is brought to 48 volts. It is also possible to modify the voltage used by connecting, either in series or in parallel, two or more networks of wire ; it is also possible to employ a regulator provided on the garment or at a fixed station. It is necessary to provide for a greater production of heat opposite those points where there is the greatest danger of cold or which are subjected to cold to the greatest extent, for example the vertebral colum, the hands, the feet.

FIG. **4** shows the left-hand half portion (back and cowl). The line **60** represents the limit of the portion which, when the garment has been completed, is sewn or welded to the other portions. The portion illustrated may however be in a single piece with contiguous portions, for example with the symmetrical right-hand portion, from the very commencement of manufacture.

The broken lines **62** show the seams connecting the two pieces of fabric between which the wires are lodged ; the sinuous lines **64** represent the same wires. It will be seen that there are ten wires for the greater portion of the back, eight for the cowl and twelve for the portion at the height of the shoulders. The wires **66,68** are connected to the conductors of the cable **56**.

The number of wires per portion may be modified and the same applies to the number of portions ; referring to FIG. **3**, one and the same portion comprises for example the front left-hand fraction of the chest, of the stomach, of an arm, of a forearm, of hand and of the front left-hand portion of the cowl. In one and the same portion, there may be a plurality of wires connected in shunt, or groups of wires connected in series. *Vice versa*, the wires of a plurality of portions may be connected in series. In those portions wherein extensibility in the direction of the heating wire is unnecessary, the said wire may be rectilinear or slightly curved.

The resistance wires may be replaced by small tubes made from a flexible material through which a hot fluid, for example water, flows. It would also be possible to provide commutators permitting the circulation of the fluid in the tubes, either in series or in parallel.

The fabrics between which the heating elements are disposed may be of different natures. They may be extensible to a considerable degree in only one direction.

The two fabrics may be assembled along the lines bordering the conduits, not by sewing but by sticking or by high-frequency welding.

Some portions of the garment illustrated may be removable, thus enabling them to be replaced at low cost when damaged or worn. This applies for example to the gloves and also to the shoes, which may be prolonged in the form of boots. It is useful to provide them with connections with which they may be supplied with heating means, i.e., electrical current, hot water, etc.

Some parts of the garment are subjected to considerable and repeated flexing, for example at the elbows, at the knees and at the instep. They cannot be provided with heating elements.

At the elbows and at the knees, the direction in which the garment flexes most is substantially perpendicular to the direction of maximum flexing of the selected garment portions. It is thus necessary to so arrange the fabrics at these points that their direction of maximum elasticity extends transversely to that in respect of the adjacent portions.

The garments according to the invention may be worn without covering them with a garment affording protection against the cold or water ; they may also be worn a undergarments. They may be worn in an excessively hot environment, if a cold fluid is circulated in tubes which replace the heating wires.

As a means of affording protecting against the cold, the garments of the invention may be employed for diving, for work in refrigeration rooms or during cold weather, in the polar regions, etc.

What we claim is:

1. Heating garment, comprising conduits each of which contain at least one heating element adapted to be connected to a source of heating medium, the garment in the zone thereof containing the heating ele-

ments being made from a fabric which is extensible at least in one direction and each said heating element being extensible at least over the greater portion of its length, characterized in that each said heating element is loosely disposed within said conduits and is extensible due to the fact that it has a configuration whereby it undulates within each of said conduits in a plane parallel to the fabrics between which it is disposed, the developed length of a portion of the heating element being at least 1.5 times the length of its mean line, and due to the fact that said conduits are formed by the assembly together of two fabrics along lines.

2. Heating garment according to claim 1, characterized in that the heating elements are maintained only by the two fabrics, by the conduits therein and by the means which connect said heating elements with said source of heating medium.

3. Heating garment according to claim 1, characterized in that the lines of assembly of said fabrics are resilient due to the nature of the substance serving to assemble said fabrics.

4. Heating garment according to claim 1, characterized in that there is a single heating element per conduit.

5. Heating garment according to claim 1, characterized in that the heating elements constitute a plurality of networks, the heating powers of the said networks being different.

6. Heating garment according to claim 5, characterized in that it comprises distributor means for energizing said heating elements, said distributor means permitting connection of heating elements either in series or in shunt.

7. Heating garment according to claim 1, characterized in that the heating elements are flexible and comprise an electrical resistance wire, consisting of a plurality of strands surrounded by a water-impermeable layer of a substance which is flexible and electrically insulating.

8. Heating garment according to claim 7, characterized in that the assembly comprising the resistance wire and the said layer is surrounded by a flexible metallic sheath which is surrounded by a water-impermeable layer of a flexible and electrically insulating substance.

9. Heating garment according to claim 1, characterized in that some of the portions thereof, are not provided with heating elements.

10. Heating garment according to claim 1, characterized in that the said fabrics are made from filaments comprising a mixture of substances which, under the action of heat, carbonize without melting.

11. Heating garment according to claim 1 characterized in that at least one portion of said garment is removable and provided with connections for feeding with heating medium.

12. Heating garment according to claim 1 wherein said assembly together of said fabrics is by sewing and further wherein the lines of assembly of said fabrics are resilient due to the sewing stitch used.

13. Heating garment in accordance with claim 1, wherein said heating elements are flexible and comprise an electrical resistance wire consisting of one strand surrounded by a water-impermeable layer of a substance which is flexible and electrically insulating.

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