July 18, 1950 J. E. FELDMAN 2,515,298

LATENT HEAT TYPE BODY-WARMING DEVICE

Filed Jan. 10, 1948 2 Sheets-Sheet 1

Fig. 1

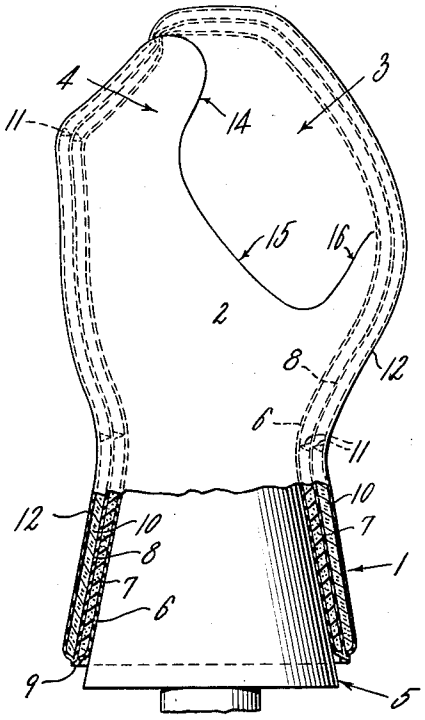
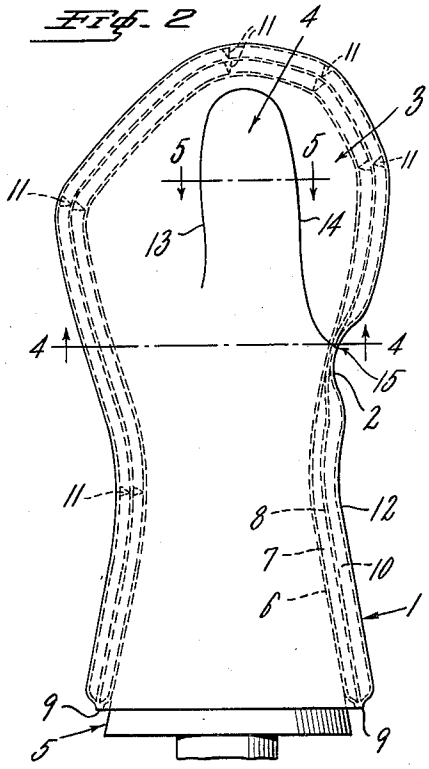


Fig. 2



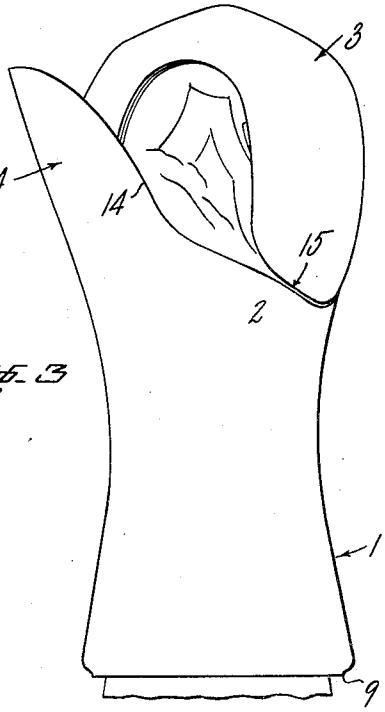


Fig. 3

Fig. 4

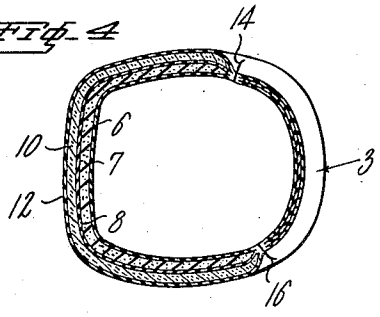
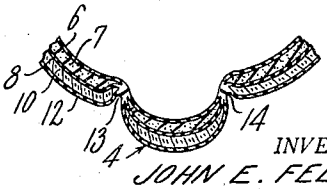


Fig. 5



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LATENT HEAT TYPE BODY-WARMING DEVICE

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Fig. 6

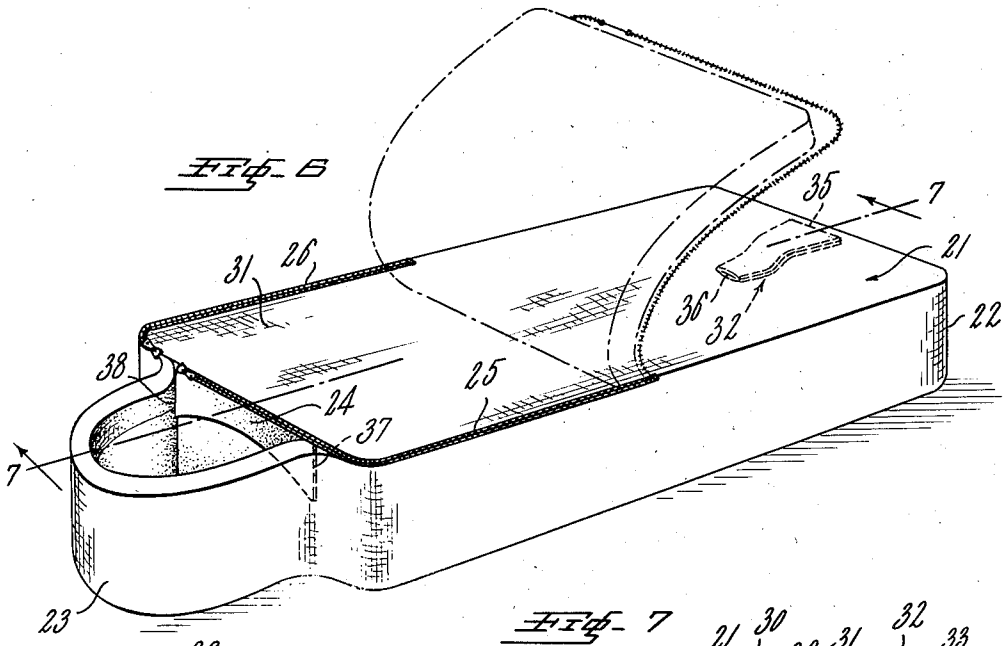


Fig. 7

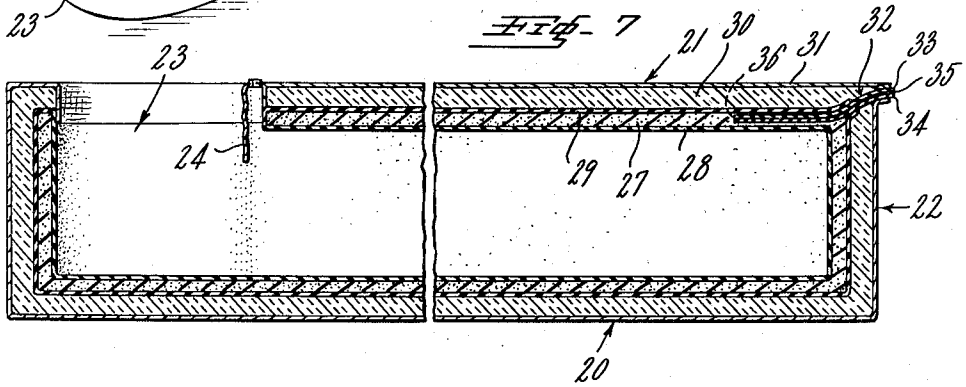
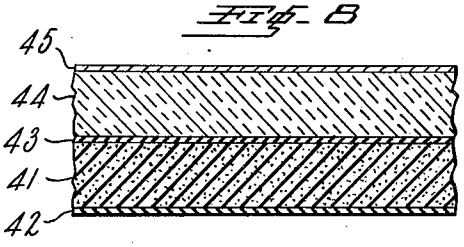


Fig. 8



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UNITED STATES PATENT OFFICE

2,515,298

LATENT HEAT TYPE BODY-WARMING DEVICE

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Application January 10, 1948, Serial No. 1,629

14 Claims. (Cl. 126—204)

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This invention relates to body-warming devices and more particularly to devices for keeping either a portion of the human body such as the hands or the entire body warm.

It has long been recognized as desirable to provide some means of maintaining the human body or portions thereof warm in cold climates or regions. This problem has been particularly serious in the case of mechanics desiring to work on equipment in cold weather or in cold regions such as the arctic regions. It has also been recognized as desirable to provide some means whereby injured or incapacitated individuals in cold regions could be kept warm until they could be transported to suitable convalescing facilities. In the past many proposals for warming the human body have depended upon an exothermic reaction to supply the heat necessary to replace that lost to the atmosphere by radiation, convection or conduction. There are many objections to use of such exothermic chemical reactions. The principal objection is the fact that they require the use of refillable or renewable cartridges since the chemical can be used but once, it being destroyed by the exothermic reaction itself. Another very serious objection to such exothermic chemical reactions is that they almost invariably require water as one of the reactants to initiate the reaction but liquid water is not available at sub-zero temperatures such as are encountered in the arctic regions. Furthermore, an exothermic reaction is very difficult to start at low temperatures in accordance with well-known chemical principles. In addition, once an exothermic reaction is started it is very difficult or impossible to control. As a practical matter there is no way of controlling it, the heat of reaction itself speeding up the reaction thereby rendering it auto-accelerating. Furthermore, the use of an exothermic reaction involves the complications attendant upon storing the reactants separately until the time when heating is desired and then bringing them into intimate contact. For these and other reasons, the use of body-warming devices based on an exothermic reaction is not feasible.

I have discovered that the human body or a portion thereof such as a hand may be warmed in a manner which completely avoids the foregoing disadvantages and solves the problem of supplying heat to the body at sub-zero temperatures by the provision of a device comprising, in combination, a layer of expanded material (preferably sponge rubber) having in its interstices an inert hydrated inorganic salt which has

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a melting point in the neighborhood of normal human body temperature, i. e. 98.6° F. (37° C.), and a heat-insulating layer on the outer side of said layer of expanded material. By heating such a device until the salt is molten and then placing it with the layer of the salt-containing material adjacent to the body, the molten salt is allowed to solidify and give up its latent heat of fusion while maintaining the temperature substantially constant over a protracted period, thereby keeping the body warm.

In accordance with my invention heat is generally not supplied in an amount sufficient to actually heat up the body but rather only enough heat is supplied to replace that lost to the surroundings by radiation, convection and conduction so that the body or part thereof can keep itself warm by the normal metabolism and the normal circulation system. For example, the human hand is naturally equipped with a circulating liquid heating system, namely the blood circulatory system. My invention makes full use of this natural system by supplying enough heat so that normal circulation is maintained but not substantially in excess of such an amount of heat. Similarly in the case of an arctic rescue bag such as is described more fully hereinafter my invention supplies only enough heat to maintain the normal circulation and metabolism of the injured or incapacitated person until he can be transported into an environment having normal room temperature.

In the accompanying drawings:

Fig. 1 is an elevation, with the wrist-covering portion partly in section, of a form having a left-handed hand-warming device of the present invention formed thereon, showing details of construction of such a hand-warming device.

Fig. 2 is an elevation taken at right angles to the view of Fig. 1.

Fig. 3 is an elevation of the hand-warming device of Figs. 1 and 2 with a human hand therein showing the thumb lifted as would be the case when it is desired to grasp an object such as a tool.

Fig. 4 is a section on the line 4—4 of Fig. 2 looking in the direction of the arrows.

Fig. 5 is a section on the line 5—5 of Fig. 2.

Fig. 6 is a perspective of a bag for use in keeping a disabled individual warm in cold regions and constructed in accordance with my invention.

Fig. 7 is a section on the line 7—7 of Fig. 6.

Fig. 8 is a section of a wall of the body-warming devices of my invention.

In its usual form, the body-warming device of the present invention comprises, in combination, the following parts:

(1) A layer of sponge rubber having its interstitial spaces filled or substantially filled with a hydrated inorganic salt which has a melting point in the neighborhood of normal human body temperature, i. e., generally within a range of from 28° to 45° C. and preferably within a range of from 34° to 37° C. and having a suitably high latent heat of fusion, preferably at least 70 B. t. u. per pound and more preferably at least 100 B. t. u. per pound and which is inert with respect to rubber, i. e., which does not deteriorate or swell or dissolve rubber, and which preferably is capable of passing through the cycle of being melted and solidified indefinitely without undergoing any degenerative change. The sponge rubber layer prevents the body of salt from becoming distorted and thereby maintains the shape of the article.

(2) An envelope surrounding the salt-filled layer of sponge rubber, this envelope being impervious to the salt when it is in either the liquid or solid form. This envelope serves to prevent loss of the salt when it is in the molten state. The envelope is almost invariably made of rubber.

(3) An insulating layer on the outer side of the layer of salt-filled sponge rubber. This serves to prevent loss of the heat given off by the molten salt as it solidifies and makes the device very much more effective than it would be without such heat insulating layer. In the case of a hand-warming device or the like made in accordance with my invention, this insulating layer is preferably made of closed-cell cellular rubber since this is an excellent heat insulator and is highly flexible. In the case of an arctic rescue bag or the like made in accordance with my invention where such extreme flexibility is not necessary and where greater thickness of insulation and greater rigidity are required, I prefer to construct this insulating layer of glass wool or similar highly heat-insulating fibrous material such as, for example, rock wool, kapok, etc.

The aforementioned parts are assembled together in permanent relationship in any suitable manner. The resulting assemblage is designed to receive the entire human body or a part thereof with the sponge rubber layer (surrounded by the above-mentioned impervious envelope) adjacent to the surface of the body where the heat is required and with the insulating layer exteriorly thereof. In use the device is heated until the salt in the sponge layer is molten and is then placed around the body or the part thereof to be warmed, whereupon the molten salt is allowed to solidify and give up its latent heat of fusion to warm the body and maintain normal circulation.

The most highly preferred salt for use in the sponge layer is hydrogen disodium orthophosphate dodecahydrate ($Na_2HPO_4 \cdot 12H_2O$) which is ideally suited for use in practicing the present invention because of its high heat of fusion (121 B. t. u. per pound) and its melting point (variously reported as 36.1° C. and 34.6° C.) which is a comfortable temperature at which to maintain the material adjacent to the body. Hyrdogen disodium orthophosphate dodecahydrate is completely inert with respect to rubber so that it will not deteriorate the rubber of the sponge or of the envelope surrounding the sponge. It is nontoxic and non-corrosive, so that no hazards attend its use. Its latent heat of fusion is considerably higher than that of any inorganic salt having a melting point in the desired range. It has the further advantage of being cheap and readily available.

Instead of hydrogen disodium orthophosphate dodecahydrate I may, although less preferably, employ other hydrated inorganic salts meeting the requisites set forth above. Examples are sodium sulfate decahydrate which melts at 32.4° C. and has a latent heat of fusion of about 103 B. t. u. per pound, sodium carbonate decahydrate which melts at 34° C., calcium chloride hexahydrate which melts at 29.9° C. and has a latent heat of fusion of about 73 B. t. u. per pound, calcium nitrate tetrahydrate which melts at 42.7° C. and has a latent heat of fusion of about 61 B. t. u. per pound, chromic nitrate monahydrate which melts at 36.5° C., ferric chloride hexahydrate which melts at 37° C., and zinc nitrate hexahydrate which melts at 36.4° C. and has a latent heat of fusion of about 56 B. t. u. per pound. Other things being equal, the greater the content of water of crystallization of the hydrated inorganic salt the greater is the latent heat of fusion thereof. For this reason preference is given to those salts which have at least ten molecules of water of crystallization per molecule.

Referring now to the hand-warming device of Figs. 1 to 5 of the drawings, there is portrayed a glove or hand-shield which enables a mechanic to work on precision machinery at low temperatures with reasonable comfort and efficiency. This device consists of a mitten-like heat-supplying rubber shield completely covering the closed hand and wrist. The device is slit around the thump, along the ends of the fingers and along the outside of the little finger to the second joint so that the hand can be opened allowing almost perfect freedom for the fingers and thumb and offering almost no resistance to handling of objects such as tools or even very small objects such as bolts or nuts. The device is preferably so constructed that it is stressed when open so that it automatically returns to the closed position when the hand is closed thereby conserving heat and allowing the operator to get his fingers warm before proceeding further. The construction is such that all components are integral with no parts to become displaced, to get out of order or to wear out.

As will be seen from Figs. 1 to 5 the hand-warming device consists of a gauntlet part 1 which fits the wrist and lower forearm snugly. In the front this tapers down as indicated at 2 to end about a third of the way into the palm of the hand. In the back the gauntlet continues down in a broad flap indicated generally as 3 which covers the fingers completely. A flap 4 also covers the back of the thumb. The device may be constructed in the following manner. A form 5 (Figs. 1 and 2) made of any suitable material and having the shape of a closed hand is first completely covered with a thin sheet 6 of unvulcanized rubber. Sheet 6 may be formed from several cut pieces allowed to overlap one another at the edges, relying upon the subsequent vulcanization step applied to the entire assembly to effect fusion of the raw rubber into an integral sheet at the laps. Then pieces of sponge rubber 7 are placed in position over the skin sheet 6. These pieces of sponge rubber are preferably so cut as to provide breaks at the wrist and at the finger joints as indicated in dotted lines and by reference numeral 11 in Figs. 1 and 2. At these breaks the edges of the sponge rubber pieces preferably touch one another so

that maximum heating efficiency is attained. The purpose of these breaks is to greatly increase the flexibility of the glove by allowing the several sections of the device to hinge freely at the joints so that the hand may be more freely opened and closed. The cut pieces of sponge rubber 7 may be secured in position on the skin sheet 6 in any suitable manner, for example by spotting with rubber cement. In placing the pieces 7 of sponge rubber on the skin sheet 6 the sponge rubber should be discontinued before reaching the line where the device is to be slit around the thumb as indicated at 13 and 14, along the fingertips as indicated at 15 and along the outside of the little finger as indicated at 16. The purpose of this is to enable the subsequent slitting operation to be carried out without cutting into the sponge rubber layer 7.

Following application of the sponge rubber layer 7 to the coated form, a second layer 8 of unvulcanized rubber similar to layer 6 is applied over the entire surface of the coated form. This second layer is extended over the edges of the sponge around the thumb into contact with the first skin sheet 6 at the wrist as indicated by reference numeral 9 and at the position of the slit around the thumb, along the tips of the fingers and along the outside of the little finger.

As the next step, cut pieces of cellular rubber 10 are placed over the exterior of the second skin sheet 8. As in the case of the sponge rubber layer 7, it is preferred that breaks in the cellular rubber layer 10 be provided at the wrist and at the finger joints as indicated by reference numeral 11 to give the device increased flexibility and to give the hand greater freedom. The pieces of cellular rubber may be secured in position in any suitable manner as, for example, by the use of rubber cement. The pieces of cellular rubber preferably touch one another at their edges along the breaks so that maximum heat-insulating efficiency is obtained.

There is then applied to the exterior of the assembly an outside coat 12 of rubber. Rubber coat 12 should extend over the edges of the cellular rubber pieces into contact with the second skin coat 8 at the wrist at 9 and along the slit to be made around the thumb, along the edge of the fingertips and along the little finger. It is highly preferred to apply the final rubber coat 12 from a liquid rubber-containing composition as by a dip-coating operation or by spraying. For example, the entire assembly may be sprayed with rubber latex to produce a film of substantial thickness say 0.06" to 0.1". By applying the final rubber coat from a liquid medium as, for example, by a dip-coating or a spraying method, no strains exist in this final coat after vulcanization of the device. As a result, after the vulcanization has been effected the device tends to return to its closed shape, the outside rubber envelope being so stressed, when the hand is opened, that the finger-covering flap 3 and the thumb-covering flap 4 automatically assume the closed position whenever the hand is closed after having been opened so as to distend flaps 3 and 4.

The assembly may next be cured. The rubber of the sponge layer 7 and of the cellular layer 10 has already been cured. The purpose of curing the assembly is to vulcanize the skin coats 6 and 8 and the outer coat 12 and to merge the rubber layers 6, 8 and 12 into an integral form at the edge of the wrist at 9 and across the position of the subsequent operation in which the device is slit around the thumb, along the ends

of the fingers and along the little finger. It will be understood that rubber layers 6, 8 and 12 contain suitable vulcanizing ingredients. If necessary, layers of rubber 6, 8 and 12 may be clamped together along the wrist at 9 and along the line of the cut, 13, 14, 15 and 16, in any suitable manner during the vulcanization step. If desired, the skin coats 6 and 8 may be fabric-reinforced. Final coat 12 will generally not be fabric-reinforced.

The device may now be removed from the form 5 and the sponge rubber layer 7 filled with the salt. Filling of the open cell structure of the sponge rubber may be accomplished in any suitable manner. One method of accomplishing this is to form a suitable opening through the wall 6 of the envelope surrounding the sponge rubber and to inject the liquid salt therethrough while manipulating the glove in any suitable manner to facilitate the substantially complete filling of the porous structure of the sponge rubber layer 7. It will be understood that if, for example, a needle through which the liquid salt is introduced enters the sponge layer 7 at a point adjacent to the wrist, fairly thorough manipulation during the filling operation will be necessary in order to effect penetration of the liquid salt into the portions of the sponge rubber farthest from the point of injection. Upon withdrawal of the injection needle the salt when molten will not leak out through the hole through which the injection was made. Preferably the assembly is maintained at a temperature above the melting point of the salt during the step of filling the sponge rubber layer 7.

An additional advantage of having the edges of the pieces of sponge touch at the breaks mentioned before is that transfer of the liquid salt from one section of sponge into an adjacent section during the filling step is thereby greatly facilitated.

Instead of using an injection method of filling the sponge layer, I may build into the assembly a suitable check valve such as the flapper valve 32 hereinafter discussed in connection with device of Figs. 6 and 7 whereby the liquid salt is readily introduced but leakage of molten salt from the device is prevented.

Before or after the filling of the sponge layer 7 with the salt and before or after removal from the form 5 the device is slit in a continuous cut extending around the thumb flap 4 as indicated at 13 and 14, thence along the ends of the fingers as indicated at 15 and along the outside of the little finger as indicated at 16. This cutting is at a position such that only the integral rubber mass formed by the union of the three layers 6, 8 and 12 is severed along the slit. The cutting step enables the device to freely open and close with the hand whereby objects can be grasped directly with the thumb and fingers through the resulting opening.

The order of the steps of removing the device from the form, filling the sponge rubber layer with the salt and slitting the device may be varied. Thus if desired the slitting of the vulcanized device may be carried out on the form after which the device may be removed therefrom and the filling of the sponge rubber layer with salt effected. Or the device may be removed from the form, then slit and then filled with the salt.

The hand-warming device of Figs. 1 to 5 has many advantages. It utilizes the circulating system of the hand to keep it warm. By eliminating tight, circulation-arresting gloves, full use is

made of this natural warming system. Supplying heat at the wrist further greatly increases the efficiency of the device. By enclosing the bare hand as a unit the loss of heat from individual fingers is kept at a minimum. By giving the fingers bare-hand freedom the time required to do a specific job is greatly reduced, which cuts down the necessary time of exposure. The use of a change of state to supply heat, namely the heat given off by solidification of a molten salt, instead of an exothermic reaction, gives almost perfect temperature control. Another advantage is that the glove when held open will always tend to return to closed position whereby if the fingers should get cold the operator can simply close his hands until they are warmed. Another advantage is that as the salt solidifies the stiffness of the device increases thereby giving an indication to the user that he should change to a freshly-heated device. Other advantages are the elasticity and flexibility of the preferred form of the device wherein closed cell cellular rubber is used as the heat-insulating layer whereby the device is constructed entirely of rubber except for the salt. If a workman is supplied with three or four pairs of the hand-warming devices of Figs. 1 to 5 in an insulated container he can work comfortably for several hours. It will be understood that in use an insulated container provided with a heating means such as a gasoline stove may be used for heating the hand-warming devices to a point at which the salt therein is molten and for keeping such devices warm until time of use.

Figs. 6 and 7 portray a rescue bag for use in keeping injured or disabled persons warm in very cold regions. The device shown in these figures is a semi-rigid, self-supporting, box-like receptacle adapted to receive the entire body and to keep it warm for a considerable period of time. Such a bag may, for example, be heated at a base and carried by airplane while maintained in a heated condition to the place where the disabled person is located, then transferred to the ground whereupon the disabled person may be placed therein and transported to a base.

The device shown in Figs. 6 and 7 comprises a bottom **20**, a top **21** and side walls **22** extending completely around the top and bottom and integral therewith. The bottom and the side walls are so shaped at one end as to form an integral head-receiving arcuate portion **23**. The top adjacent the head-receiving portion **23** is so arranged that it can be swung upwardly as shown in dotted lines on Fig. 6 to permit the placement within the receptacle of the disabled individual. There is provided a throat flap **24** which is adapted to lie across the individual's throat, thereby giving a tight closure. Flap **24** is hinged to the wall at one end as by cementing at **37** and is free at the other end **38**. Slide fasteners **25** and **26** are provided along the edges of the swingable portion of the top to detachably secure this swingable portion into position. As shown, the upper edge of flap **24** carries a portion of one cooperating slide fastener element of slide fastener **26**, this portion being continuous with the portion along the wall of the bag.

The arctic rescue bag shown in Figs. 6 and 7 comprises a layer **27** of sponge rubber which has its cellular structure filled or substantially filled with a salt of the type described above. Layer **27** is completely surrounded as before with an impervious rubber envelope comprising an inner wall **28** and an exterior wall **29**. Outside of the thus-enveloped layer of sponge rubber there is provided a layer **30** of heat insulation which preferably is fibrous, such as glass wool. It is preferred that this heat insulating layer be at least 4" thick in order to reduce the loss of heat outwardly to a minimum.

The layer **30** of insulation is surrounded by any suitable covering layer **31** which may be of rubber but generally is of cotton duck, canvas or similar woven textile fabric.

The sponge rubber **27** may be filled with the salt in any suitable manner. There is illustrated the use of a flapper valve **32** which is built into the assembly, extending from the outside thereof through the insulation layer **30** and through the outer wall **29** of the envelope into the sponge rubber layer **27**. Flapper valve **32** may be composed of the usual two parallel walls **33** and **34** of rubber cemented together at their edges. The liquid salt is introduced through the opening **35** and passes between the walls **33** and **34** into the sponge rubber layer **27** through opening **36** at the innermost end of the flapper valve **32**. Thereafter and during use, the flapper valve **32** remains closed as a result of the hydraulic pressure of the liquid salt in known manner.

Instead of having the throat flap **24** constructed as shown in Figs. 6 and 7, in some cases it may be preferable to have it carried by and constructed integrally with the top **21**. In such case the slide fastener **25** ends at a point corresponding to that at which the slide fastener **26** on the other side of the bag ends and the flap is lifted with the top of the bag when it is desired to place the injured person within the bag or to remove him therefrom. Such a construction is simpler than that shown in Figs. 6 and 7 of the drawing and is simpler to operate in extremely cold regions. In such case it is desirable to have the flap **24** constructed of thick, cushioning, heat-insulating material. For example it may be constructed with several inches of resilient insulation whereby when the top is placed in position and fastened down the throat flap lightly but tightly presses against the throat of the individual in such manner as to effect a good seal without interfering with his comfort or safety. If desired the throat flap so constructed may comprise a body of sponge rubber filled with the heat-supplying salt, formed for example by an integral continuation of the layer **27** of sponge together with the envelope formed by layers **28** and **29** into the throat flap **24**.

By the use of an arctic rescue bag such as is illustrated in Figs. 6 and 7 a stricken human being may be kept warm for 48 hours at an outside temperature of minus 70° F. assuming that the insulation layer is at least 4" thick, that the sponge rubber layer **27** contains 150 pounds of hydrogen disodium orthophosphate dodecahydrate and that the individual's body is capable of supplying enough heat to keep him alive, namely, 1500 calories per day. It will thus be seen that a device such as is illustrated in Figs. 6 and 7 makes readily possible the rescue of stricken human beings in very cold isolated areas such as the arctic regions. The device of Figs. 6 and 7 offers many advantages. It can be used indefinitely, it being necessary only to warm it until the salt in the sponge rubber layer is molten in order to prepare it for use.

If desired, a more flexible construction than that shown in Figs. 6 and 7 may be provided for enclosing an entire human body. For example an oversized sleeping bag type of structure may be provided.

Fig. 8 shows in exaggerated detail a section through a wall of a body-warming device made in accordance with my invention. In Fig. 8 the salt-filled sponge rubber layer is indicated by the reference numeral 41, the impervious envelope surrounding the sponge rubber layer is shown as being formed from the innermost wall 42 and an outer wall 43, while the heat insulating layer is indicated by reference numeral 44 and the outermost layer is indicated by reference numeral 45.

Sponge rubber is by far the preferred material for holding the heat-liberating salt used in the present invention. However, other expanded material may less preferably be employed in place of sponge rubber. In the case of a hand-warming device or other device where elasticity and free movement are necessary the material used for containing the salt should be elastic and flexible. An example of other material which might be used in place of sponge rubber is closed cell cellular rubber, provided that the difficulty and expense of introducing the salt into the cells are not prohibitive. Another material which can be used is honeycomb rubber, that is sheet rubber which has been assembled into a cellular structure. In some cases it may be feasible to place particles of the salt into rubber prior to vulcanization thereof. However, none of these alternative methods is nearly as feasible as the use of sponge rubber, which has an open structure, and introduction of the salt thereinto after construction of the device as described above.

It is preferred, particularly in the case of the arctic rescue bag of Figs. 6 and 7 or a similar device, that the layer of sponge be cemented to the faces of the envelope discontinuously—for example, in spots—so that the liquid salt can pass between the face of the sponge rubber layer and the face of the envelope rather than through the sponge rubber which consumes considerably more time. This is not absolutely necessary in the case of the hand-warming device because it is circular in shape so that the sponge may be held against the faces of the envelope without cementing although cementing to the inner skin layer 6 may facilitate assembly.

The sponge rubber layer should be sufficiently thick to hold enough of the salt to keep the body or part thereof for which the device is designed warm for the requisite length of time. The thickness of the sponge layer will depend upon, among other factors, the degree of cellularity of the sponge rubber (sponge rubber usually contains from 50 to 80% voids), the particular salt employed and the amount of outward loss of heat which will depend upon the efficiency of the insulating layer. In the case of a hand-warming device, the sponge layer is preferably at least ¼" thick. In the case of an arctic rescue bag, the sponge layer may conveniently be from one to two inches thick in order to have an adequate reserve of heat.

The layers of rubber making up the envelope which surrounds the layer of sponge rubber are usually quite thin, generally not over $\frac{1}{16}$" in thickness, being only thick enough to have the strength necessary to resist the influences to which they are subjected in manufacture and use. The thickness of the outer rubber layer 12 is generally of the same order although it may be somewhat thicker, if desired, to resist abrasion and wear.

The thickness of the insulating layer will depend upon the particular type of insulating material used, the outside temperature encountered, the length of time it is desired that the device supply heat, etc. In the case of a hand-warming device insulated with closed cell cellular rubber the insulating layer will usually be at least ¼" thick. In the case of an arctic rescue bag insuated with fibrous material, the insulating layer will usually be at least 4" thick.

Any form of heat insulating material may be used provided it is capable of being adapted to the particular body-warming device in question. In the case of hand-warming devices or similar devices used at moderately low temperature the insulation is preferably of cellular (closed cell) rubber. In the case of body-warming devices which are to be used at temperatures of the order of minus 75° F., especially those devices which do not need to be highly flexible or to possess elasticity, I prefer to employ fibrous insulation such as balsa wood, balsam wool, cork, hair felt, kapok, hair and jute, rock wool, glass wool, etc., the latter being preferred because of its light weight and high insulating value at such extremely low temperatures.

While the invention has been described with particular reference to a hand-warming device and an arctic rescue bag, it will be understood that the principles of my invention can be employed in constructing any type of body-warming equipment such as foot-warming devices, leggings, arm-warming devices, sleeping bags, blankets, vests, underwear, such as a complete suit of underwear, headgear, jackets, overcoats, flexible suits adapted to cover the entire body and to be worn while moving about, etc.

Having thus described my invention, what I claim and desire to protect by Letters Patent is:

1. A body-warming device, comprising, in combination, a layer of cellular material having in its interstices a hydrated inorganic salt which has a melting point in the neighborhood of normal human body temperature and which is inert with respect to said cellular material, and a heat-insulating layer on one side of said layer of cellular material, said device being adapted to be heated until said salt is molten and to then be placed with said layer of cellular material adjacent the body and with said heat-insulating layer exteriorly thereof whereby said molten salt may solidify and give up its latent heat of fusion to keep the body warm.

2. A device as recited in claim 1 wherein said salt is hydrogen disodium orthophosphate dodecahydrate.

3. A body-warming device comprising, in combination, a layer of sponge rubber having in its interstices a hydrated inorganic salt which has a melting point of from 28° to 45° C. and a latent heat of fusion of at least 70 B. t. u. per pound and which is inert with respect to rubber, an envelope completely surrounding said layer of sponge rubber, said envelope being impervious to said salt when in the molten state, and a heat-insulating layer on one side of said layer of sponge rubber, said device being adapted to be heated until said salt is molten and to then be placed with said sponge rubber layer adjacent the body and with said heat-insulating layer exteriorly thereof whereby the said molten salt may solidify and give up its latent heat of fusion to warm the body.

4. A device as recited in claim 3 wherein said salt is hydrogen disodium orthophosphate dodecahydrate.

5. A warming device adapted to keep the hand

warm and at the same time to permit the grasping of objects directly with the fingers and thumb which comprises, in combination, a flexible inner layer of sponge rubber conforming to and adapted to substantially completely enclose the hand, said sponge rubber containing in its interstices a hydrated inorganic salt which has a melting point of from 28° to 45° C. and a latent heat of fusion of at least 70 B. t. u. per pound and which is inert with respect to rubber, an envelope completely surrounding said layer of sponge rubber, said envelope being impervious to said salt when in the molten state, and a flexible layer of heat-insulating material conforming to said sponge rubber layer and surrounding same exteriorly thereof, the device having a slit around the thumb, along the fingertips and along the outside of the little finger whereby the hand can be opened sufficiently to permit the grasping of objects directly through the resulting opening.

6. A device as recited in claim 5 wherein said salt is hydrogen disodium orthophosphate dodecahydrate.

7. A hand-warming device adapted to keep the hand warm and at the same time to permit the grasping of objects directly with the fingers and thumb which comprises, in combination, a flexible inner layer of sponge rubber conforming to and adapted to substantially completely enclose the closed hand, said sponge rubber containing in its interstices a hydrated inorganic salt which has a melting point of from 28° to 45° C. and a latent heat of fusion of at least 70 B. t. u. per pound and which is inert with respect to rubber, a rubber envelope completely surrounding said layer of sponge rubber, said rubber envelope being impervious to said salt when in the molten state, a layer of closed cell cellular rubber conforming to said sponge layer surrounding same exteriorly thereof and exteriorly of the outer portion of said envelope, and an impervious rubber envelope surrounding said layer of cellular rubber exteriorly thereof, the device having a slit around the thumb, along the fingertips, and along the outside of the little finger whereby the hand can be opened sufficiently to permit the grasping of objects directly through the resulting opening, said last-named rubber envelope being so stressed that the device automatically assumes the closed position whenever the hand is closed, the layers of rubber of said envelopes merging integrally at both edges of said slit and at the wrist.

8. A device as recited in claim 7 wherein said salt is hydrogen disodium orthophosphate dodecahydrate.

9. A device for keeping a disabled human being warm in cold regions comprising a receptacle adapted to receive the human being, the walls of said receptacle comprising an inner layer of sponge rubber containing in its interstices a hydrated inorganic salt which has a melting point of from 28° to 45° C. and a latent heat of fusion of at least 70 B. t. u. per pound and which is inert with respect to rubber, an envelope completely surrounding said layer of sponge rubber, said envelope being impervious to said salt in the molten state, and a layer of heat-insulating material surrounding said sponge rubber layer exteriorly thereof and exteriorly of the outer portion of said envelope.

10. A device as recited in claim 9 wherein said salt is hydrogen disodium orthophosphate dodecahydrate.

11. A device as recited in claim 9 wherein said receptacle is generally flat, having a bottom, a top and side walls, the bottom and the side walls forming at one end of said receptacle an integral arcuate portion adapted to receive the head of the disabled individual, a sufficient portion of said top adjacent to said arcuate portion being adapted to be swung upwardly to permit placement within the receptacle of the disabled individual, and slide fastener means for detachably securing said swingable portion of said top to said walls.

12. The method of making a hand-warming device which comprises providing a form having the general configuration of a closed hand, covering said form with a layer of unvulcanized rubber, applying thereover a layer of sponge rubber, said sponge rubber layer being so shaped as to terminate on each side of a line extending around the thumb, along the fingertips and along the outside of the little finger, applying a second layer of unvulcanized rubber over said layer of sponge rubber, said first and second layers of unvulcanized rubber extending beyond the sponge rubber layer and contacting each other at the wrist and along said line, applying over said second layer a layer of heat-insulating material, said heat-insulating layer being so shaped as to terminate on each side of said line, applying a third layer of unvulcanized rubber over said layer of heat-insulating material, said third layer extending beyond said layer of heat-insulating material and contacting said second layer at the wrist and along said line, vulcanizing the assembly and thereby curing said layers of unvulcanized rubber and merging same into integral form at the wrist and along said line, subsequent to vulcanization filling the interstices of said sponge rubber with a molten hydrated inorganic salt having a melting point in the neighborhood of normal human body temperature and which is inert with respect to rubber, and subsequent to vulcanization cutting through said device along said line whereby to enable it to be opened so that objects can be grasped directly.

13. The method of claim 12 wherein said heat-insulating layer is closed cell cellular rubber.

14. The method of claim 12 wherein said third layer of rubber when applied is in the form of a liquid rubber-containing composition whereby after vulcanization no strains exist in said third layer of rubber but said layer is so stressed, when a hand within the device is opened that the finger-covering and thumb-covering flaps formed by said cutting step automatically assume the closed position when a hand within the device is closed after having been opened so as to distend said flaps.

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REFERENCES CITED

The following references are of record in the file of this patent:

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