Feb. 5, 1963 H. K. SHAW ET AL 3,076,206

SURVIVAL-APPAREL AND RELATED SURVIVAL-GEAR

Filed Jan. 28, 1960

FIG. 1.

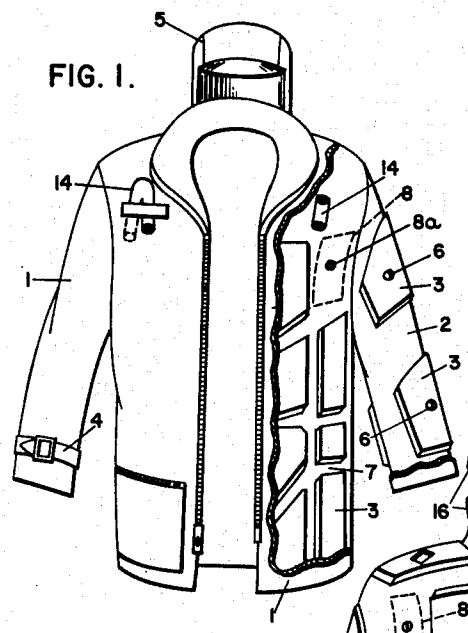
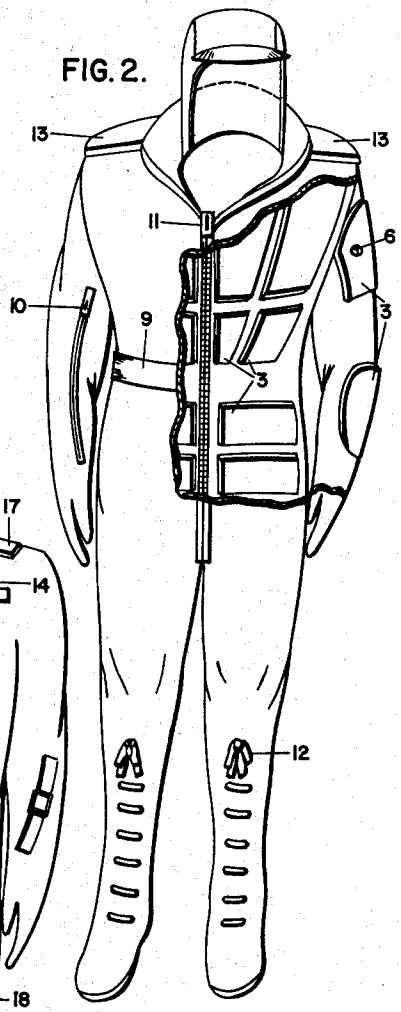


FIG. 2.



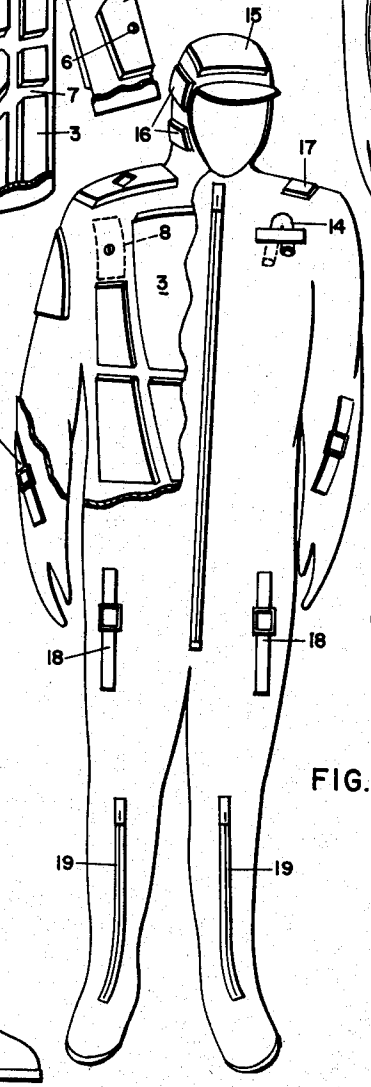
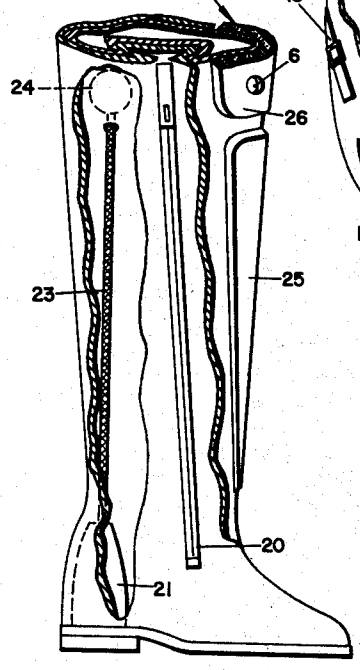


FIG. 3.

EXPANDED CLOSED-CELLULAR FOAM

FIG. 4.



INVENTORS.
HUBERT KINNEY SHAW
EDWARD C. CRAIG

United States Patent Office 3,076,206 Patented Feb. 5, 1963

3,076,206

SURVIVAL-APPAREL AND RELATED SURVIVAL-GEAR

Hubert Kinney Shaw, Springfield, Mass., and Edward C. Craig, Stone Ridge, N.Y.; said Hubert K. Shaw and Helen S. Craig, executrix of the estate of said Edward C. Craig, deceased, assignors to International Applied-Research Corporation, Wilbraham, Mass., a corporation of Massachusetts

Filed Jan. 28, 1960, Ser. No. 5,248
10 Claims. (Cl. 9—330)

This invention relates to amphibian survival-apparel and survival-gear for which flexibility, buoyancy, insulation, and comfort are necessary characteristics. The invention also adapts itself for use in other units than apparel-gear, e.g., in combination with inflatable buoyancy in rafts, boats, pontoons, and the like. Extensive tests have proved that the interdependent survival features claimed in the present invention are especially valuable in anti-exposure immersion-suits, flotation-coveralls, and in amphibian sports-jackets and sports-shirts.

Our invention is useful for operators and occupants of waterborne or airborne craft of all types, as well as for sportsmen, fishermen, dock personnel, bridge repairmen, search-and-rescue personnel, flood rescue-workers, firemen, policemen, campers, water-skiers, snow-skiers, skaters, and other outdoorsmen, women and children whose activities expose them to wind, water, and a wide variation of temperatures.

Preparedness is of vital importance in matters of survival. If an item of survival apparel-gear is too heavy, too bulky, too rigid, too costly to manufacture, its usefulness is accordingly limited. In fact, the history of survival apparel-gear indicates that the use and purposes of such equipment may be delayed for generations unless the objections are removed. The object of this invention is to combine the interdependent elements of multipurpose survival-appear and related survival-gear.

It seems that the greater the range of utility, the greater the chances that such apparel-gear will be used by the persons who may later become involve in an emergency situation but who neglect to use apparel or gear designed solely for emergency-protection. Our invention, therefore, is designed to meet the interrelated needs of survival apparel-gear.

Experience has shown that a simple construction is needed for reducing vapor-tension, (i.e., the pressure of a confined body of vapor) isolating condensation-moisture, and increasing air-circulation within amphibian apparel. A simple construction is also needed for horizontally self-righting a person who is wearing a flotation-coverall, especially in the event that he is a non-swimmer and falls into the water in a face-downward position. Leg-coverings of amphibian-coverall units need initially to be of ample circumference for easy donning, but also need to become reasonably close-fitting later when the wearer enters the water. Furthermore, there is need for a practical means of reducing "cargo" of water from a coverall-unit which may have leaked due to damage in an accident, etc. It is likewise important, when the seams of amphibian apparel are electronically "welded," that the area adjacent to the seams be adequately reinforced in order to resist tearing. In this connection, it is important to point out the fact that the range of materials and methods of construction must be sufficiently practical and economical to permit retail prices which customers are willing to pay.

Finally, survival-apparel needs a simple means of providing auxiliary warmth at and near the feet in very cold temperatures; and, for very hot tempertures, there is need for a simple means of providing cool air.

The Present Invention

The present invention is the result of extensive experimenting with segments of soft, closed-cellular foam of various dimensions and shapes, from ¼" to 1¼" in thickness. We have utilized neoprene closed-cellular foam weighing approximately 4 pounds per cubic foot; vinyl closed-cellular foam, 5 pounds per cubic foot; polyethylene closed-cellular foam, 2 pounds per cubic foot; and other synthetic compounds, all of which can be joined to fabrics by the use of special adhesives or by the use of sewing equipment. Certain types of thermoplastic foam, moreover, can be joined to thermoplastic sheeting, coated or uncoated fabrics by means of electronic sealing.

The buoyant and insulating characteristics of expanded, closed-cellular foam have been comparatively well-known to manufacturing specialists, engineers, and the like, during the past generation. As Mr. Kienitz pointed out in his Patent No. 2,226,564, the material was recommended for life preservers in the report of the Committee on Commerce relating to the investigations of the S.S. Morro Castle and Mohawk disasters. During the past quarter-century since then, the combined resiliency and strength of cell-structure of gas-expanded, closed-cellular foam have successfully withstood the rigorous tests of time and usage. (On May 2, 1958, the Department of Transport, Ottawa, Canada, officially approved buoyant plastic foam for life-preserver use, CGSB Specification 41–GP–8; 65–GP–1; and on June 25, 1958, the United States Coast Guard did likewise, Life-preserver Specification Supbart 160.052.)

The primary objectives of our research and experimentation in the development of the present invention have been maximum comfort and adaptability to numerous types of activity, in order to provide a maximum of preparedness for unexpected emergency situations.

The advantages of buoyancy and insulation are the result of the unique non-connecting cell structure of gas-expanded, solidified rubber or plastic foam; hundreds of thousands of separate cells (containing nitrogen or other gas) per cubic inch of foam.

The comfort and adaptability advantages of the present invention are the result of combining modern materials in a unique manner, to provide, along with buoyancy, flexibility, etc., adequate means of air-circulation and ventilation, to aid in evaporating the vapor which is constantly excreted from the human body in the form of "insensible perspiration." A further accomplishment, of special importance in flotation-coverall or immersion-suit units, is the "isolation" of condensation-moisture between the inner and outer layers of sheeting.

Especially in areas such as under the arms and adjacent areas, between, or/and adjacent to, the knees, or other locations where ventilation and air-circulation are particularly desirable, apertures or "perforations" may be cut or stamped, in various sizes (for example, ½" or 1"), in various shapes (such as square, oblong, circular, triangular, etc.) through the solidified foam. In addition to providing ventilation, the perforation method retains structural strength with increased flexibility. In apparel-gear units designed solely for warm-weather use, perforations may, if desired, extend not only through the solidified-foam interlining but also through the outside layer and/or inside layer of covering material. For units designed solely for cold-water use, optional perforations extend only through solidified-foam interlining or semi-interlining (segments); but in both types of construction, the perforations serve to provide added circulation of air concurrently with body-motion of the wearer. The "walls" of the stamped perforations may be perpendicular, or at an oblique angle if preferred, with re-

lation to the outside and inside coverings of sheet material.

The use of strips or segments of solidified foam, as well as the perforated areas, permits a "siphoning" action along the channels and spaces which separate the segments, and back and forth through the apertures (when the solidified foam is perforated).

Any desired apparel-pattern may be cut from sheets of solidified foam, or from laminated sheeting and solidified foam, perforated or otherwise. Whenever practical, precut segments of rubber or plastic solidified foam may be used, being joined to either or to both outside-covering and inside-covering layers by means of adhesives, sewing, quilting, radio-frequency sealing, etc.

The concurrent "bellows-action" or siphoning-motion of air with each motion of the wearer's body, due to the channels and other air-spaces, is an important means of increasing the wearer's comfort and efficiency. Even the motion of the diaphragm in respiration serves to produce the analogous reaction in the multipurpose apparel-gear. To fulfill their basic purposes, survival-apparel and gear must be comfortable; otherwise, people often tend to feel embarrassed or self-conscious in wearing it.

Isolation of Condensation

In the present invention, we have also shown that condensation moisture, heretofore one of the primary difficulties encountered in water-impermeable survival-apparel, can be isolated in the following manner; (this is even more important and noticeable in anti-exposure flotation-coveralls than in amphibian coats or jackets). The outer layer of the amphibian apparel is, for this purpose, constructed of water-impermeable material, and the inside or lining-layer is constructed of vapor-permeable material which has been treated with a suitable water-repellent solution, such as "Aridex" or "Zelan."

The vapor from the wearer's body readily penetrates the vapor-permeable lining-layer, then goes through the channels and spaces which separate the solidified-foam segments, and finally condenses into drops of water against the inner surface of the outside (water impermeable) layer of material. (In the case of previous types of immersion-coverall, this moisture would then cause the wearer's ordinary clothing to become wet, resulting in general discomfort.) In the present invention, however, the condensation-moisture does not return through the water-repellent lining-layer. It penetrates one way, in the form of vapor, but does not return after it has condensed into water. After the coverall-unit is removed, the condensation-moisture gradually evaporates; but meanwhile, the water-repellent lining-layer has served effectively as a moisture-barrier. Such a combination is especially useful for extremely cold and/or extremely windy weather conditions, when it may be desirable to reduce the evaporative heat-loss from the body but where comfort and efficiency are, as always, important, too.

For weather that is both warm and wet, the outside layer of material may be constructed of material which is not only water-impermeable but to a considerable degree, vapor-permeable; and the lining-layer may be of ordinary vapor-permeable fabric. In warm weather, it is generally desirable to expedite (rather than to retard) evaporative heat-loss; and for warm-weather use, the following construction is especially useful.

Both the outside and inside layers of sheet material may be constructed of air-porous fabric, either or both of which may be water-repellent-treated with a solution such as "Aridex" or "Zelan." The strips of buoyant material are, in this instance, joined to the fabric of an ordinary shirt or jacket, as well as being adaptable for coat and coverall types of apparel. The amphibian garments constructed in this manner can be comfortably worn even on hot days, times when the largest number of boating accidents occur.

To provide both physiological and psychological motivation for wearing a "cool-air" amphibian garment in warm weather, one of the modifications of the present invention is as follows: removable sacs containing beads of adsorbent desiccant, e.g., the material commercially known as "Sovabead," may be inserted in the channels or spaces of the amphibian apparel, as, for example, near the armpits, in order to expedite the evaporation of body-vapor. Further, it becomes psychologically useful to the youngster (or older person, as the case may be) to be able to find additional reason for wearing the survival-apparel; it helps to keep him comfortable, cooler than he might be without it. Then, if he becomes too preoccupied in combatting a record-size fish, or if his boat capsizes or hits a rock, he may luckily find himself wearing a multipurpose survival-garment even on a hot, humid day.

The same construction which helps to keep the wearer cool in summer helps to keep him comfortable if he is exercising vigorously in cool or cold weather; for example, when skating or skiing. If, despite warnings, he falls through ice, he will find that his sports-garment has instantly transformed itself into a survival-garment. The same principles and logic apply in the case of multipurpose buoyant snowsuits for children and little tots. If they venture too near the edge of a brook or river and fall into it, they will be able to clamber out or to shout and attract the attention of rescuers.

The channels and spaces between the buoyant segments afford further usefulness in the tropics or in the extremely hot boiler-rooms of steamships, etc. Both layers of sheet material may, for such purposes, be constructed of water-impermeable material; and sacs of "Dry Ice" or other types of refrigerant may be inserted (and removed and refilled when necessary).

Reinforced Electronic Construction

In electronic sealing, two thermoplastic films, pieces of unsupported thermoplastic sheets, or thermoplastic-coated fabric or an outer layer of thermoplastic sheeting and a lining layer of vapor-porous, woven-filament fabric are placed against each other, and the superposed plies are subjected to high-frequency electronic "welding," which fuses the two plies, the fusion beginning in the midthickness of the material and proceeding outward.

A "weld" of that type causes a weakening of the materials just outside the area of high-frequency sealing. (The same is true in the welding of metals.) Another feature of the present invention is the application of a strengthening-tape which extends across the joint and onto the main body of the fabric, film, or sheeting, in the neighborhood of the joint and covers the weaker area which is adjacent to the seam itself. There are numerous examples in prior art where seams are reinforced; but it is significant in the present invention that the area requiring reinforcement is not actually a part of the seam, but adjacent to the seam. In plastic rainwear, umbrellas, and the like, it has not been deemed necessary to resort to means of reinforcing the weakened area, due to the very low cost of such items and the customary "repeat sales." In survival-apparel and gear, however, efficient performance and durability are of paramount importance. Accordingly, the adequate reinforcement of the "weakened area" adjacent to electronically-welded seams is important when amphibian apparel is constructed by this method. The tapes or strapping used for reinforcement may be attached to the outside, inside or to both sides, of the adjacent "weakened area," depending on the types of material used.

In cannot be emphasized too strongly that numerous structural features are interrelated and interdependent for optimum and proper functioning of multipurpose survival apparel-gear. Concerning anti-exposure coverall-units, if too many different sizes are required, it is proportionately difficult for owners of passenger-craft to furnish

adequate survival apparel-gear for everyone on board (at different times). In prior art, horizontal take-up straps are well known. In the present invention, however, are optional pairs of "vertical" take-up straps, which serve to reduce extra slack lengthwise; e.g., when immersion-coverall units are worn by individuals who are shorter in stature than the units would otherwise accommodate; hence, fewer different-size units adapt themselves to fit a greater number of persons, as needed.

Similarly, more persons will protect themselves with insulated anti-exposure and swim-coverall-units in cold water if the leg-covering portions are constructed as follows: adequately voluminous for convenience in donning the coverall-unit easily, but also adaptable to fit the legs snugly before the wearer enters the water. The present invention, therefore, includes means of reducing excess fullness by gussets or goring, plus lacing, drawcords, or slide-closures, etc., below the knee—and, optionally, above the knee-portions. In like manner, circumferential fullness may be reduced, if desired, in the sleeves and/or at each side of the body-portion between the leg-coverings and underarm area.

For the purpose of "vertical" self-righting, Mr. Stoner's coverall-units in 1868 (U.S. Patent No. 74,168) had metal weights. He explained that his invention had "for its object to furnish an improved apparatus by means of which persons when compelled to commit themselves to the water in case of accident on steamboat or shipboard may sustain themselves for days or until they are rescued. . . . K are metal shoes or weights fitting upon the feet, the greater part of the weight (about five pounds) being collected upon the instep . . . ."

In the present invention, both horizontal and slanting-position self-righting become possible by means of two co-acting features: (1) the provision of means for reducing the fullness in the leg-coverings, as summarized in the preceding description of take-up straps, plus means for drawing together snugly the gusset-like front or/and side portions of the leg coverings, particularly from the instep to the knee; closure means may be for example, conventional boot-lacing method, spiral, around-the-leg lacing, drawcords, slide-closures, spring-clasps, stud-fasteners, or buttons. Especially important is the provision of feature (2): buoyancy (preferably in the form of very light, closed-cellular solidified foam, such as neoprene, polyvinyl, polyethylene, or (in sealed compartments) polyurethane, up to ½ cubic foot in volume, said buoyancy being located across the upper-front portion of the coverall-unit (between the neck and the thighs, and optionally extending across the abdomen); plus additional buoyancy material (or equivalent inflatable buoyancy) located in the front of the leg-coverings.

Experience in horizontal self-righting tests conducted in Boston Harbor indicated that the positioning of less than ½ cubic foot of buoyant material in the upper front portion, and less than ¼ cubic foot of buoyant material in the front of the leg-portions of an immersion-coverall unit served to co-act in a unique manner and was shown to be horizontally self-righting. The coverall-unit and the wearer, or "occupant," were seen to be analogous (in their combined "superstructure" and "ballast") to the construction of a ship, the spine of the wearer representing the "keel," and the weight of shin- and knee-bones being counteracted as much as practicable by the anterior-buoyancy units at the shin-bone and knee-bone areas. The simplest form of the unique self-righting feature is achievable by utilizing inflatable compartments which also contain segments of solidified foam,, which may be of either closed-cellular or interconnecting-cellular type.

Concerning the buoyancy required in the self-righting features of construction, it is pointed out that it is customary to test volumes of buoyancy by use of iron weights in the water. In confirming the effectiveness of self-righting coverall units, however, tests were conducted in a sea-water harbor by individuals wearing flotation-coverall units.

Studies of the evolution of flotation-coveralls during the past century indicate that another problem has been that of leakage, although the problem has been sometimes misinterpreted. It should be pointed out that, as far as survival is concerned, a leaky coverall-unit of water-impermeable material affords far more protection than no coverall at all. Body-heat gradually warms the enclosed leakage-water. One person made the thoughtful observation that he would much prefer to have some lukewarm or cool water within a windproof, protective coverall-unit of substantially water-impermeable material (if he also had sufficient buoyancy provided to support himself and his clothing) than the alternative of using his own body-warmth to increase the temperature of the ocean (or lake, river, etc.) adjacent to his body.

If a coverall unit has developed leakage, it is nevertheless desirable to have a means of removing the leakage-water; e.g., at such times as when survivors are being picked up by a rescue lifeboat and will need to continue to wear the coverall as anti-exposure apparel in the boat or raft; or when the rescue is performed by a helicopter. A flexible plastic or rubber syringe and tubing may be included as an integral part of the flotation-coverall unit and the accumulation of leakage-water can thus be reduced to a minimum, the syringe functioning in the manner of a boat's bilge-pump.

If adequate buoyancy (from 16 to 32 ounces of closed-cellular foam of approximately 4-pounds-per-cubic-foot density) is provided to support the wearer of the flotation-coverall unit, plus his regular clothing and the ordinary contents of his pockets, the flotation-coverall unit itself could be completely "flooded" without danger of sinking. Water which might leak into a coverall-unit as a result of damage, etc., simply displaces an equal volume of outside water.

For extremely cold temperatures, auxiliary heat is desirable. Shaw in his U.S. Patent No. 2,647,507 provides a water-activated chemical-heat unit which can be transferred to various locations within the coverall-unit. A feature of the present invention for the purpose of distributing warm air more thoroughly (at very cold outside temperatures) is the optional provision of two small-size chemical-heat units, one in each of the foot-coverings, positioned in back of the heel and at right angles (approximately) to the sole of the foot. These units may be attached by a cord or tape means, one end of the aforesaid cord or tape being attached to the knee-portion, or adjacent area of the coverall-unit. The heat-units may be positioned between the lining and the outside layer of the coverall-unit, apertures being provided in the lining or between the lining-layer and the wearer's legs. If heat-units are positioned between the lining and the outside layer, apertures of adequate size are provided in the lining to allow the wearer to remove and reinsert the heat-units, as desired, for purposes of reactivating the chemical heat-compound. Each heat-unit should be relatively light in weight, e.g., containing approximately 4 ounces of heat-compound, each. Other means than chemical heat may be utilized within the scope of this invention.

In the earlier part of this specification, we have stressed the use of expanded, closed-cellular foam. There is also another complementary benefit from a related product, foam-rubber or foam-plastic of interconnecting-cellular type. As a further modification, we provide, optionally, inserts of interconnecting-cellular foam, the function of which is to provide additional bellows-like motion of air within the coverall-unit. It also adds resiliency. It is practical to join the two types of cellular foam so that the closed-cellular layer is adjacent to the outside covering of the coverall or other unit of buoyant apparel and the interconnecting-cellular foam is ad-

jacent to the inside covering (lining) of the apparel unit.

Interconnecting-cellular "foam-bellows" inserts are especially useful in and adjacent to foot-coverings, underarm or adjacent areas, between the knees or adjacent areas. Such inserts, either independently or joined to closed-cellular-foam inserts, may be placed wherever desired, for specialized types of activity, and may be included in small sacs, for example in combination with chemical-heat compound, or with desiccant material.

A further modification of amphibian survival-coveralls is described as follows: From the waist upward at least as far as the neck (and optionally as far as the top of an attached helmet-portion), the coverall-unit is constructed of two layers of sheet material, with an interlining of buoyant expanded-cellular material, or interconnecting-cellular material, or both. The buoyant jacket-portion in this modification is provided with means for inflating that portion (by mouth-tube or CO_2 cartridge). At least the jacket-portion is constructed of substantially vapor-and-water-impermeable material, a substantially airtight seam being provided where the jacket-portion is joined to the leg-covering portion of the coverall-unit. This same combination of buoyant solidified foam plus inflatable buoyancy is adaptable to all types of amphibian apparel-gear, e.g., vests, jackets, and bib-front overalls.

Material used in multipurpose survival-apparel may be treated with suitable flameproofing compound, such as ammonium sulfamate, by dip, spray, or brush-on methods. Fabrics which are to be treated with a solution of water-repellent may first be treated with suitable flameproofing compound and subsequently treated, by dip, spray, or brush-on methods, with water-repellent solution. The latter then provides a secondary function of helping to prolong the effectiveness of the preceding treatment (flameproofing).

FIGURE 1 is a partly broken-away front elevational view of an amphibian jacket unit showing the features of the present invention.

FIGURE 2 is a partly broken-away front elevational view of an amphibian sportswear-coverall-unit showing the features of the present invention.

FIG. 3 is a partly broken-away front elevational view of an amphibian emergency-wear coverall-unit incorporating the features of the present invention.

FIGURE 4 is a fragmentary partly broken-away elevational view in large scale showing in vertical section a modified form of leg-and-foot covering.

Seams may be sewed, cemented, strapped, or/and electronically "welded," depending on the materials used and the particular requirements of usage, etc. Any segments of solidified foam (whether closed-cellular or interconnecting-cellular) may be molded, if desired, and may be joined to either covering (or both).

Shown in FIGURE 1 is a reversible buoyant jacket constructed of two layers of sheet material, "outside" and "inside" layers, **1** and **2** respectively, which are joined at their peripheral edges. To either layer (or to both layers, if preferred) are joined (by cementing, sewing, stapling, electronically sealing, or other method) spaced segments **3** of buoyant closed-cellular solidified foam. Sleeves may be provided with adjustment-straps **4**. An optional hood of the parka type **5** may also be provided. Segments **3** may also be equipped with "foam-bellows" layers and/or apertures, or "perforations" **6**. Channels separating the segments **3** provide circulation of air and as a result, increased comfort. Channels **7** may intersect at either right or oblique angles. Removable pads **8** of desiccant may be provided to aid in drying air, especially under conditions of high humidity. Each pad **8** containing the desiccant beads may be joined to its layer or layers as by snap-fastener **8***a*. The desiccant beads may be reactivated by exposing them to dry atmosphere in an oven at a temperature between 200° F. and 500° F., for about 20 minutes, all as is known.

As mentioned earlier in this specification, the segments **3** comprise soft, closed-cellular foam of various dimensions and shapes, and may be from ¼" to 1¼" in thickness. In experimentation, we have utilized closed-cellular foam comprising neoprene, vinyl, polyethylene, and other synthetic compounds. Each may be joined to the inner and/or outer layers by the use of special adhesives, or of special types of sewing materials so as to achieve a quilting effect, or by electronic sealing.

By the use of these segments, each comprising a non-connecting cell structure of gas-expanded solidified rubber or plastic foam, as aforementioned, we offer a tremendous multiplicity, hundreds of thousands, of separate closed gas-containing cells per cubic inch of foam.

Reference has been made in this specification to the perforations **6** through the foam of the segments **3**. Such are especially desirable, as aforesaid, in areas, such as under the arms and knees and adjacent areas, or other locations where ventilation and air-circulation are particularly desirable. These apertures or "perforations" may be cut in various sizes and in various shapes. In addition to providing ventilation, the perforation method assures retention of structural strength while simultaneously offering increased flexibility.

As aforesaid, the perforations may be arranged to extend transversely through the segments in a manner perpendicular to the main axes of the segments, or alternatively, they may be arranged to extend obliquely therethrough.

Also as set forth above, in the case of apparel-gear units designed solely for warm-weather use, these perforations may extend not only through the solidified-foam segmented interlining but also through the outside layer and/or the inside layer. Contrariwise, for units designed solely for cold-weather use, the perforations may extend only through solidified-foam segmented interlining. In both types of construction, the perforations will serve to provide added circulation of air concurrently with the body-motion of the wearer.

It is to be appreciated, as has been previously stated, that the use of the segments allows a "siphoning" action along the channels and spaces which separate the segments, and back and forth through the apertures (when the solidified foam is perforated). There is a "bellows-action" or siphoning-motion of the air with each motion of the wearer's body, due to the channels and the other air-spaces, which serves as a means for increasing the wearer's comfort and efficiency.

It is to be explained that the segments may be formed from sheets of solidified foam, or from laminated sheeting and solidified foam (either of which foam forms may be preperforated), along any desired apparel-pattern.

And it is also worthy of note, as mentioned earlier herein, that condensation moisture, offering such problems as it does in the case of water-impermeable survival-apparel, can be isolated where the outer layer is constructed of a water-impermeable material, and the inside or lining-layer may be constructed of a vapor-permeable material, which may have been treated with a suitable water-repellent solution. The vapor from the wearer's body will readily penetrate the vapor-permeable lining-layer, then pass through the channels or spaces separating the solidified-foam segments, and finally condense into drops of water against the inner surface of the outside (water-impermeable) layer.

Heretofore in prior art types of immersion-coveralls, this moisture would cause the wearer's ordinary clothing to become wet, resulting in the wearer's general discomfort.

Contrariwise however, by the construction herein comprehended, this condensation-moisture does not return through the water-repellent lining-layer. It penetrates one way in the form of vapor, and it does not return after it has condensed into water wherefor the water-repellent lining-layer has served effectively as a moisture-barrier.

On the other hand, in the case of applications where the

weather is both warm and wet, the outside layer may be constructed of a material which is both water-impermeable and vapor-permeable and the lining-layer may be of an ordinary vapor-permeable material, all for the reason that in warm weather, it is generally desirable to expedite (rather than to retard) evaporative heat-loss. For such warm-weather use, both the outside and inside layers may be constructed of an air-porous fabric, either or both of which may be water-repellent-treated.

The structure, so far described and comprising the inner and outer layers (and the segments sometimes referred to as interlinings), provides, as was set forth in the preamble hereof, along with buoyancy and flexibility, and adequate means for achieving air-circulation and ventilation, all so as to aid in evaporating the vapor constantly being excreted by the body of the wearer in the form of insensible perspiration. The structure functions to isolate the condensation-moisture between the said inner and outer layers.

The aforementioned removable pads or sacs **8** containing the beads of adsorbent desiccant may be inserted within the said channels or spaces between the segments, as, for example, near the armpits, all so as to expedite the evaporation of body-vapor.

Alternatively, the channels or spaces between the buoyant segments, in the case of applications in extremely hot areas, can be employed to accommodate sacs of "Dry Ice" or other types of refrigerant.

As shown in FIGURE 2, a belt **9** may be used in a sportswear coverall-unit of the "continuous-wear" type. Also, for convenience and for adjustable ventilation, vertically-extending sleeve-openings between upper and lower portions of the sleeve may be provided and may be equipped with slide-closures **10** of known type. A central vertically-extending opening of the coverall-unit may be provided with a slide-closure **11**. Fullness of leg-coverings may be reduced by means of lacings **12**. Optionally, such lacing may be spiraled around the leg, from instep and ankle to a point just below the knee.

Coverall-units may also be reversible, and, like the jacket-units, may have one of the covering-layers of a bright color, such as "international orange" or red. Buoyant epaulets **13** may be joined to either the interior or the exterior surface(s) of the coverall or jacket units. For supplementary buoyancy, inflating-tubes **14** may be added, all for the purpose of inflating the space between the outside and inside layers, and if desired, said tubes may be provided with CO_2 cartridges.

In FIGURE 3 are shown anti-concussion, shock-insulating segments **15**, **16** attached to the helmet-portion, to protect, or reduce injuries to the wearer's head in case it collides with floating objects; for example, at night or in thick fog. A shoulder-tab **17** may be secured to the outer surface of the outer layer and may be provided is for attaching a waterproof flashlight and/or jackknife by means of a lanyard, spring-clamp, safety-clasp, or the like. "Vertical" adjustment-straps **18** are provided for adjusting the length of the sleeves and leg-coverings, especially to allow better fitting of individuals being protected from exposure aboard lifeboats, liferafts, etc. Slide-closures **19**, which may extend from the instep to a point just below the knee and, if desired, also above the knee, may be used as an alternative to the lacing, drawcord, clasp, or button methods of closure, all so as to reduce the circumference of the leg-coverings.

As shown in FIGURE 4, closure means (e.g., slide-closures **20**) may be provided at the side instead of at the front of the leg-covering portion of the amphibian coverall-units. Heat-units **21** may be provided in each of the foot-coverings or/and attached leg-portions, said heat-units being insertable through appropriate openings in the outer layer, said openings being closed as by slide closures, snap fasteners, buttons, or the like and the heat-units being attachable at the heel area to the sole or at right angles to the sole by suitable means, and extending from the heel upwardly toward the calf of the leg, and/or also joined, if desired, by a cord **23** to a reinforcing-patch **24** in the back or sides of the knee-area. If preferred, a slide-closure (separable), stud-fastener, or other means may be used to attach the heat-unit in the knee-area so that the heat-units can be more easily transferred from the back to the front and/or from the side to the side of the leg coverings, as when the wearer is working on a deep-sea fishing trawler in winter, or is wading at low tide from shore to an off-shore island in cold temperature. (Similar means may be used for attaching small heat-units in or adjacent to the wrist area of the sleeves, if desired.) Optional buoyancy-segments **25** may extend from the instep up the front and/or sides of leg-coverings as far as may be desired, or separate knee-buoyancy segments **26** may be provided in the knee area.

In the case of the electronic sealing of layers as by welding, as we have heretofore mentioned, such a weld causes a weakening of the materials just outside the area of high-frequency sealing. Accordingly, we envision the application of a strengthening-tape which extends across the joint and onto the main body portion of the layer or layers adjacent the joint so as to cover the weaker area adjacent the seam per se. The area requiring such reinforcement is not actually a part of the seam, but is a portion adjacent the seam.

These tapes used for such reinforcement may be attached to the outside, inside or to both sides, of the adjacent "weakened area", all depending on the types of material used.

We claim:

1. In water-impermeable coats, the improvement comprising an outside layer of water-impermeable sheet material, an interlining consisting of a plurality of segments of flexible, buoyant, expanded closed-cellular solidified foam, said segments being spaced from each other and providing a plurality of interconnecting criss-crossing channels, and a lining of vapor-porous, water-repellent fabric, said outside layer and lining being secured to each other at all peripheral edges thereof, to provide isolation of condensation moisture between said outside and lining layers.

2. In water-impermeable coveralls, the improvement comprising an outside layer of water-impermeable sheet material, an interlining consisting of a plurality of segments of flexible, buoyant, expanded closed-cellular solidified foam, said segments being spaced from each other and providing a plurality of interconnecting criss-crossing channels, and a lining of vapor-porous, water-repellent fabric, said outside layer and lining being secured to each other at all peripheral edges thereof, to provide isolation of condensation moisture between said outside and lining layers.

3. In water-impermeable coats, the combination comprising an outside layer of water-impermeable sheet material, an interlining layer of expanded, flexible, closed-cellular solidified foam, said interlining layer being punctured at intervals to provide transverse perforations for the purposes of flexibility and ventilation, and a lining of vapor-porous, water-repellent fabric, said outside layer and said lining layers being secured to each other at or adjacent to the peripheral edges thereof, to provide isolation of condensation moisture between said outside and lining layers.

4. In water-impermeable coveralls, the combination comprising an outside layer of water-impermeable sheet material, an interlining layer of expanded, flexible, closed-cellular solidified foam, said interlining layer being punctured at intervals to provide transverse perforations for the purposes of flexibility and ventilation, and a lining of vapor-porous, water-repellent fabric, said outside layer and said lining layers being secured to each other at or adjacent to the peripheral edges thereof, to provide isolation of condensation moisture between said outside and inside layers.

5. In anti-exposure protective coats, the combination

comprising an outside layer of water-impermeable sheet material, an interlining consisting of a plurality of panels of flexible, expanded closed-cellular solidified foam, said panels being spaced from each other and providing a plurality of interconnecting channels, said panels also being punctured at intervals to provide transverse perforations for the purposes of flexibility and ventilation, and a lining of vapor-porous, water-repellent fabric, said outside layer and lining being secured to each other at all peripheral edges thereof, to provide isolation of condensation moisture between said outside and lining layers.

6. In anti-exposure protective coveralls, the combination comprising an outside layer of water-impermeable sheet material, an interlining consisting of a plurality of panels of flexible, expanded closed-cellular solidified foam, said panels being spaced from each other and providing a plurality of interconnecting channels, said panels also being punctured at intervals to provide transverse perforations for the purposes of flexibility and ventilation, and a lining of vapor-porous, water-repellent fabric, said outside layer and lining being secured to each other at all peripheral edges thereof, to provide isolation of condensation moisture between said outside and inside layers.

7. In anti-exposure protective coats, the combination of an outside layer of water-impermeable, thermoplastic sheet material, an interlining of perforated, thermoplastic expanded closed-cellular solidified foam joined by electronic sealing to said outside layer, and a lining of vapor-porous, water-repellent fabric, said outside layer and lining being secured to each other by electronic sealing at all peripheral edges thereof, to provide isolation of condensation between said outside and lining layers.

8. In anti-exposure protective coveralls, the combination of an outside layer of water-impermeable, thermoplastic sheet material, an interlining of perforated, thermoplastic expanded closed-cellular solidified foam joined by electronic sealing to said outside layer, and a lining of vapor-porous, water-repellent fabric, said outside layer and lining being secured to each other by electronic sealing at all peripheral edges thereof, to provide isolation of condensation moisture between said outside and lining layers.

9. In water-impermeable coveralls, the combination as described in claim 2, including removable sacs containing adsorbent desiccant beads, said sacs being positioned adjacent the underarm areas of the apparel.

10. In anti-exposure coveralls, the combination as described in claim 2, and a pair of attached moisture-activated chemical-heat units, one of said units being joined by a cord to the inside surface of the coverall's left leg covering, the other of said heat units being joined by another cord to the inside surface of the coverall's right leg covering, each of said cords permitting both feet and both legs of the wearer to be warmed simultaneously.

References Cited in the file of this patent

UNITED STATES PATENTS

1,221,417	Cheek	Apr. 3, 1917
1,504,916	Teiber	Aug. 12, 1924
1,771,730	Marcks	July 29, 1930
2,129,742	Mason	Sept. 13, 1938
2,195,736	Myers	Apr. 2, 1940
2,329,093	Sommers	Sept. 7, 1943
2,335,630	Bachardy	Nov. 30, 1943
2,349,480	Walk	May 23, 1944
2,414,051	Mallory	Jan. 7, 1947
2,421,533	Akerman	June 3, 1947
2,621,342	Boyle	Dec. 16, 1952
2,629,116	Frieder	Feb. 24, 1953
2,629,118	Frieder	Feb. 24, 1953
2,647,507	Shaw	Aug. 4, 1953
2,664,566	Mianulli	Jan. 5, 1954
2,794,756	Leverenz	June 4, 1957
2,803,023	Rosenberg	Aug. 20, 1957
2,842,771	Foti	July 15, 1958

FOREIGN PATENTS

6,955	Great Britain	1899
805,173	France	Aug. 17, 1936
557,220	Great Britain	Nov. 10, 1943

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,076,206 February 5, 1963

Hubert Kinney Shaw et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 38, for "survival-appear" read -- survival-apparel --; line 41, for "involvo" read -- involved --; column 9, line 53, for "and may be provided is for" read -- may be provided for --.

Signed and sealed this 24th day of December 1963.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWIN L. REYNOLDS

Acting Commissioner of Patents