Jan. 5, 1954 A. R. MIANULLI 2,664,566

FLEXIBLE SHELL SUIT

Filed June 22, 1951 2 Sheets-Sheet 1

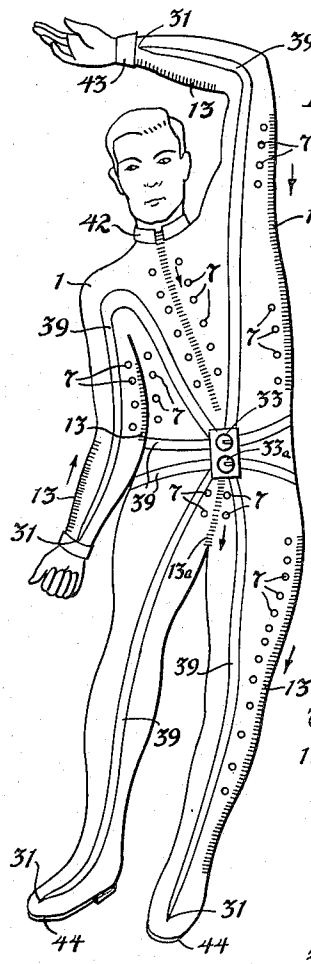


Fig. 1.

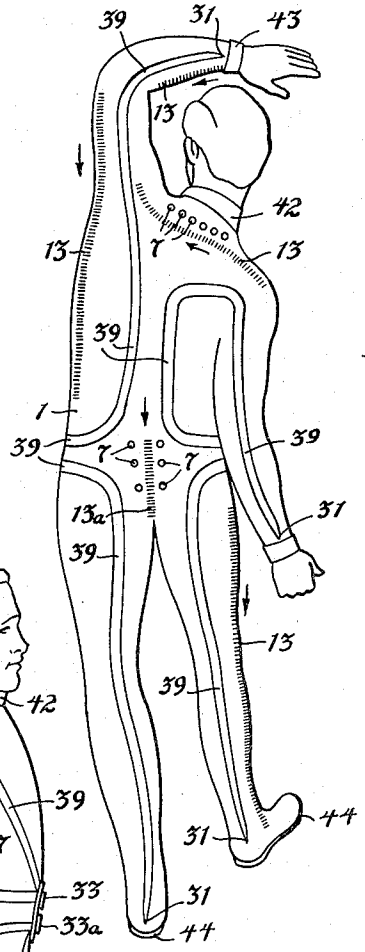


Fig. 3.

Fig. 2.

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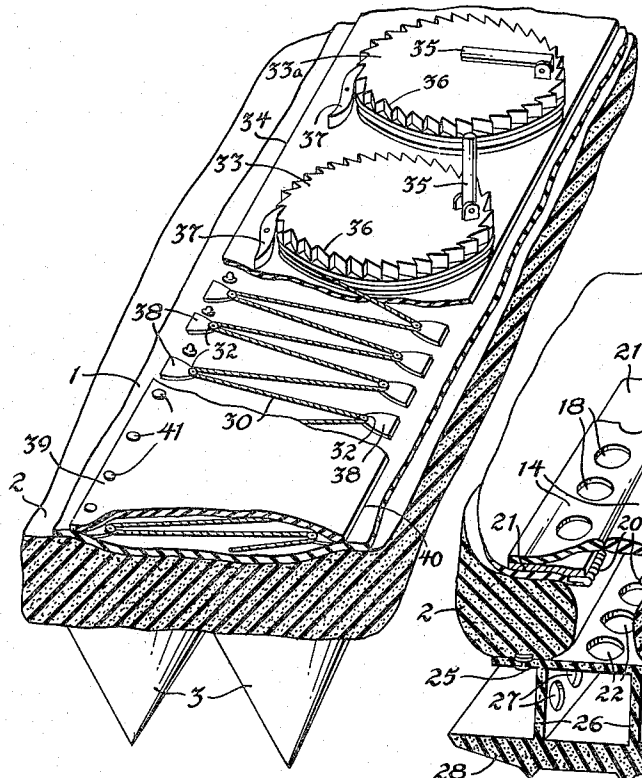


Fig. 6.

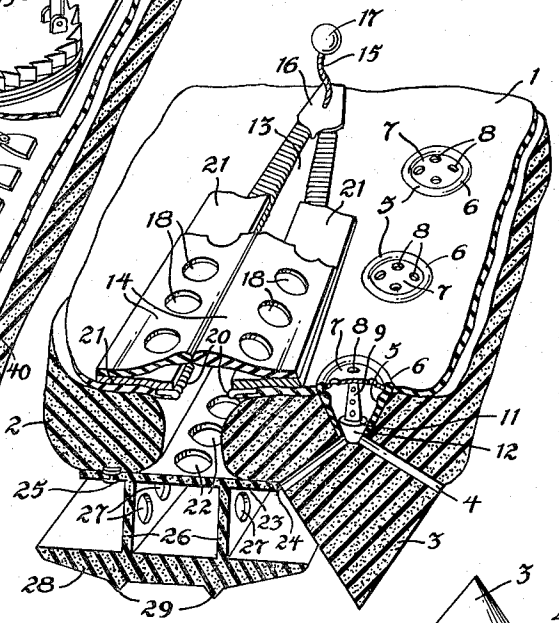


Fig. 4.

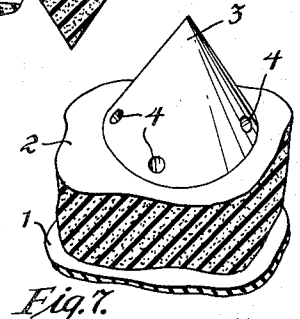


Fig. 7.

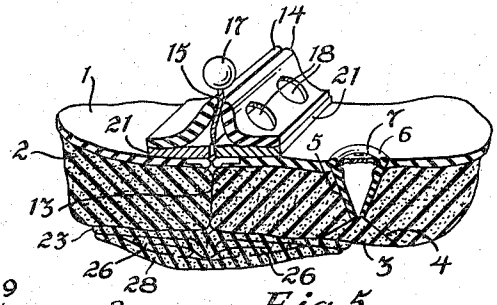


Fig. 5.

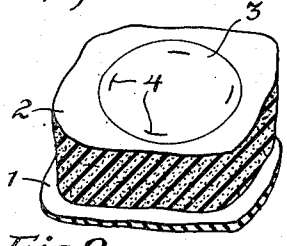


Fig. 8.

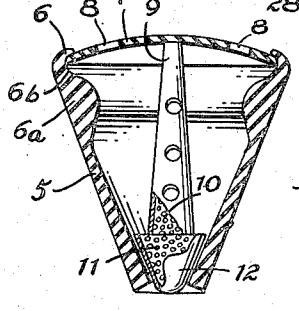


Fig. 9.

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UNITED STATES PATENT OFFICE

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FLEXIBLE SHELL SUIT

Avo R. Mianulli, Philadelphia, Pa.

Application June 22, 1951, Serial No. 232,914

6 Claims. (Cl. 2—2)

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My invention relates to a new and useful flexible shell suit and has for one of its objects to provide an article of wearing apparel particularly adapted for use by a person in the military service to protect the wearer against climatic conditions or the elements of weather, extreme shocks due to contact with hard stationary objects, and blows resulting from propelled missiles.

Another object of the invention is to provide a protective suit that forms, in effect, a flexible shell about the wearer's body to protect him, or her, from inclement and other climatic or weather conditions and for absorbing shocks incident to contact with stationary objects or being hit by missiles.

Another object of this invention is to produce a protective suit of the character mentioned as a one-piece article to be worn without any additional wearing apparel, either inside or outside of said protective suit.

The construction of the protective suit herein described permits controlled ventilation to all parts of the wearer's body, is water-proof and all openings can be temporarily sealed to prevent seepage of water to the interior thereof so that the wearer can enter a body of water, either purposely or accidentally, without the likelihood of the suit becoming water logged, and adds buoyancy to the wearer to assist in keeping him afloat for long periods of time. The outer surface of the suit is smooth and tough and therefore is not easily snagged or cut and the inside surface of the inner laver is soft and non-irritating while the body portion is elastic and shock absorbing whereby the possibility of bodily injury to the wearer when active about rough terrain is minimized. Also this type of suit allows greater freedom of activity at a minimum of effort because it is light in weight and does not have the bulk and inerr-clothing friction of multiple layers of wearing apparel.

Therefore, another object of the present invention is to provide a tough yet soft resilient protective suit having ventilating means which can be sealed when occasion requires.

Another object of this invention is to produce a suit of the kind described provided with means to contract portions thereof in order to adjust the pressure of the suit on the wearer and to make it form-fitting to a considerable range of body sizes.

Another object of the invention is to produce a protective suit which is sanitary because the materials used do not readily absorb dirt and can be easily cleaned and is provided with "Zipper" controlled openings so located that the suit can

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be readily and quickly put on or taken off to permit cleaning of the person or a change of suits, permit access to any part of the body for attention to injuries or wounds or the cleansing of certain body areas without removal of the suit and permit elimination of body waste through the smallest possible openings while fully clothed. Such a suit protects the wearer, to a large degree, from the harmful effects of radioactivity and injurious gases.

A further object of the invention is to form foot coverings or shoes as unitary parts of the suit which function to assist in holding said suit in place, in one direction, without undue binding forces which might result from the use of cords, other ties or the like thus eliminating any uncomfortable binding action on any particular part of a wearer's body and allowing maximum ventilation of the feet and freedom of movements for the purpose of comfort.

A still further object of this invention is to produce an exceedingly efficient suit for the purpose intended which is extremely economical because it can be manufactured faster and at less cost than the conventional clothing since it requires less operations to make it, and because there are less sizing problems, less cleaning and repair costs and it can outlast all of the articles of wearing apparel which it replaces.

Because of the strength and toughness of the materials of which the suit is constructed, a pack carrier can be attached directly thereto without the use of straps or other auxiliary supporting means and metal or plastic protective plates can be added to the suit, particularly in the region of the more vulnerable parts of a person's body, such as the localities of the vital organs.

With the above and other objects in view this invention consists of the details of construction and combination of elements hereinafter set forth and then designated by the claims.

In order that those skilled in the art to which this invention appertains may understand how to make and use the same I will describe its construction in detail, referring by numerals to the accompanying drawing forming a part hereof, in which:

Fig. 1 is a front view of the flexible shell suit constructed in accordance with my invention and illustrating its appearance when on a human being.

Fig. 2 is a side view thereof.

Fig. 3 is rear view of the same.

Fig. 4 is an enlarged sectional perspective view of a portion of the suit looking at the outside thereof in the region of any one of the "Zipper"

controlled openings, some parts being broken away to illustrate details of construction, the walls of the opening being separated and some parts shown in expanded condition.

Fig. 5 is a view of a portion of Fig. 4 with opening closed and parts of the suit contracted and compressed.

Fig. 6 is a view similar to Fig. 4 in the region of portions of the draw cords and the reels for controlling said cords.

Fig. 7 is a view, in sectional perspective, of a smaller portion of the suit, and looking at the inside, showing one of the mounds expanded.

Fig. 8 is a like view showing the mound compressed.

Fig. 9 is an enlarged vertical sectional view of one of the ventilating casings and its closure or stopper illustrated partly in elevation and partly in section.

In carrying out my invention as herein embodied 1 represents an outer surface layer of flexible, water-proof material, such as plastic or rubber sheeting, attached to a rather thick inner or insulation layer 2 comprised of a compressible or resilient material, such as "Airfoam" latex, which is extremely porous. From the inside surface of said inner layer project compressible cone shaped mounds 3 of the same or the same type of material, being formed as integral parts thereof or attached thereto as a unitary article. The purpose of the mounds is to generally maintain an air space between the walls of the suit and the body of the wearer, including the torso, legs and arms.

The suit is provided with a plurality of breathing or pore openings 4 in the form of tapered holes communicating with the exterior of said suit in the regions of the mounds and running straight inwardly a suitable distance but terminating short of the plane of the inside surface of the inner layer 2 and then spreading out into several angular radial branches with terminals on the surfaces of the mounds adjacent the bases thereof for communication with the interior of the suit.

In the tapered outer end of each pore opening 4 is fixedly mounted a frusto-conical shaped water and mud guard or valve casing 5 of deformable water-proof material having an inturned flange 6 at the mouth thereof and an internal annular rib 6a spaced inwardly from the flange 6 a distance suitable to provide an annular channel 6b. A cover 7 of relatively hard or stiff material has a plurality of air holes 8 through it adjacent the perimeter which is forced past the flange 6, because of the latter's elasticity or resiliency, to register with the channel 6b and normally be retained in place therein. Whenever the cover 7 is pressed inwardly relative to the casing 6 the flange and rib will be deformed and forced inwardly radially to cover the air holes 8 thereby preventing mud or other foreign matter from entering the casing 6. Due to the sliding action of the flange over the outer surface of the cover, any substance adhering thereto will be wiped off to maintain the air holes in open condition.

Attached to the inside of the cover 7 at the center thereof is a hollow perforated conical stem 9 of relatively hard material and positioned so that the smaller end is at the cover. Within the stem is a filler 10 of porous material, such as sponge, having an enlarged head portion 11 protruding from or located outside of the larger end of said stem 9 and covered by a water-proof membrane 12. The membrane covered head portion 11 cooperates with the normally open smaller outlet end of the frusto-conical casing 5 to function as a valve for closing said outlet end under certain conditions.

The filler 10 being of porous and absorbent material, should any water enter the casing through the air holes 8 a sufficient amount of the water will be absorbed by the filler to cause the latter to expand and move the membrane covered head 11 into tight fitting engagement with walls of the casing to close the outlet end thereof and prevent entrance of water to the interior of the suit.

There are a multiplicity of the mounds 3 distributed at random on and projecting from the inner surface of the suit walls throughout the trunk, arms and legs thereof so that while the suit is being worn the apexes of said mounds engage the wearer's body and normally maintain the suit walls in spaced relation thereto providing an air chamber all about the wearer. The valve controlled air holes 4 permit a circulation of air to and from the air chamber to keep the wearer's body at a desired temperature.

The ventilation is controlled by varying the amount of air passing through the pores or air holes 4 by more or less compressing the mounds and said pores may be fully closed by completely compressing said mounds as shown in Fig. 8.

Ventilation is also accomplished through the "zipper" controlled placket openings 13 and the "zipper" controlled fly opening 13a. The preferred locations of the placket openings are illustrated in Figs. 1, 2 and 3 and the direction of movement of the "zipper" slides for opening the plackets and fly is indicated by the arrows adjacent the lines diagrammatically depicting the placket openings in said figures. Desirably, there is a placket opening along the forearm portion of each sleeve, another at each side of the trunk and underneath portion of each sleeve extending from approximately the waist upwardly to and across the armpit and longitudinally of the sleeve to approximately the elbow, another longitudinally of each leg from approximately the hip to the foot, one extending from the neck to the region of the waist and still another across the upper part of the back from shoulder to shoulder. The fly opening 13a extends from the waist at the front of the suit under or along the crotch to the rear of the suit also at about the waist line. While each of the "zipper" fasteners controlling the placket openings include only one slide, the fastener for the fly opening includes two slides, one to control the front portion and the other the rear portion from the waist to approximately midway of the crotch. In practice, the slides on the fly fastener are both moved downwardly for opening the fly for purposes of ventilation and as a convenience for the elimination of body waste.

Rain and mud guard flaps 14 are arranged in pairs along the entire length of each placket and the fly opening, the outer longitudinal edges of said flaps being secured in place to the suit walls adjacent the edges of the material forming the openings as shown in detail in Fig. 4. The inner edges of said flaps are slightly thickened and are sufficiently resilient to generally remain in contact to cover the fasteners and, under certain conditions, function to prevent entrance of water or mud to the interior of the suit. However, said flaps may be progressively flexed to permit the slide cable 15, which is attached to the fastener

slide 16, to be moved from one end to the other of a placket or the fly opening and the outer end of said slide cable may be provided with a ball 17.

With the exception of the placket opening across the back of the suit, from shoulder to shoulder, each flap 14 has a series of longitudinally spaced holes 18 to allow air to pass to or from each placket or fly opening 13 and 13a, respectively. With respect to the placket opening across the back this opening is generally substantially horizontal when the wearer is standing or sitting upright and in this case the holes 18 are provided only in the lower flap and the upper flap is imperforate.

The toothed elements 20 of each fastener are attached to the outer layer 1 of the suit walls adjacent the edges of each placket and fly opening and an extra layer 21 of similar material is imposed on each toothed element and fixed to suit walls to keep the fastener teeth clean without interfering with the proper operation of the fastener slide or slides.

Whenever a placket or the fly opening is in an open condition any air entering them from the exterior will pass through holes 22 in a spread stop 23 made of flexible sheeting, such as rubber or plastic. One longitudinal edge of the spread stop 23 is permanently attached to the inside of the suit at one side of a placket or the fly opening, as at 24, while the other or opposite longitudinal edge is detachably secured at the opposite side of the opening by means of the elements of snap fasteners 25 or equivalent attaching means. This method of assembling the spread stop 23 prevents the wall edges of each placket and the fly opening from spreading too far apart under ordinary conditions in which the suit is employed but permits such openings to be fully opened when and if desired. During the time said spread stop is attached at both sides of an opening the wall edges are maintained separated, due to the inherent stiffness of said spread stop, sufficiently to allow a free flow of air through the holes.

From the rear surface of the spread stop 23 project a pair of parallel supports 26, of the same elastomeric material as said spread stop, one on each side of the row of holes 22, and said supports have a series of longitudinal holes 27, arranged in rows. The supports 26 carry a back stop 28 of compressible elastomeric material slightly thicker than and generally in parallel relation to the spread stop and under certain conditions functions as a baffle to deflect the streams of air entering the holes in the region of a placket or the fly opening whereby said streams of air are not directed immediately against the wearer's body. The back stop, preferably, has feathered edges and from the outer surface of said back stop, or that surface opposed to the wearer's body, project a plurality of small conical protuberances 29 for contact with the wearer's body to space said back stop therefrom and assist the mounds in maintaining the desired air chamber between the wearer and the walls of the suit.

When the fly and placket openings are closed, as suggested by the showing in Fig. 5, the opposed adjacent edges of the tooth cover layers 21 are moved into intimate contact and the flaps 14, being in edgewise engagement when said fly and placket openings are open, will be turned outwardly to assist in shedding water or shunting other foreign matter to one side away from the holes 18. As the suit is contracted, by means to be presently described, the mounds 3 will be compressed and the spread stops 23 along with the supports 26 folded under the back stops 28 as the latter approach the inside surface of the inner layer of the suit walls, see Fig. 5, thus securely sealing the fly and placket opening against the entrance of extremely cold air, water or any foreign matter to the interior of the suit.

A means for contracting the suit for sizing and air chamber control is diagrammatically shown in Figs. 1, 2 and 3 by a number of parallel lines enclosing spaces representing cover strips 39 and illustrating that the suit contracting means extend from the wrists longitudinally of the sleeves, on the anterior sides thereof and downwardly in oblique directions on opposite sides of the front of the trunk to a location at the waist line and also on the posterior sides of the sleeves from the wrist portions to the backs of the shoulders, then downwardly to the waist line and along the latter to the front of the suit. The above may be considered as the upper half of the suit contracting means and in a similar manner the lower half of the suit contracting means extend from adjacent the toes along the anterior sides of the legs to the front of the waist and also from the heel portions of the legs along the posterior sides of said legs, longitudinally thereof, and thence along curvilinear lines in the regions of the hips and waist line to the front of the suit at the waist where winding reels are located.

Specifically, as herein shown, for purposes of illustration, the suit contracting means includes a number of cables 30 having one end of each fixedly secured to what I will term an extremity of the suit, indicated at 31, and which may be the wrists of the sleeves and the toe and heel portions of the foot sections of the suit legs. By referring to Fig. 6 it will be noted that each cable runs in zig-zag fashion through a series of pulleys 32 to a reel 33 on which the opposite end of said cable is partially wound. Preferably there are two reels 33 and 33a, one above the other, and the cables controlling sleeves and the upper part of the trunk above the waist run to reel 33 while the cables controlling the legs and lower part of the trunk below the waist run to reel 33a.

Since the construction and operation of the parts of the controlling mecahnism for contracting the suit are duplicates, the description of one will suffice for an understanding of all, wherefore, for the most part, only one will be described in detail.

The reels are journalled on axles mounted on a hard or stiff plate 34 which is attached to the outside surface of the front of the suit at the waist for easy access of the wearer. Each reel has a folding handle 35 for winding the respective cables thereon to the degree desired, for partially contracting the suit, or to completely contract the suit to a person's body. Each reel is held in any adjusted position by a pawl 37 pivotally connected with the mounting plate 34 and coacting with ratchet teeth 36 located about the perimeter of the associated reel. By preference, the pulleys 32 are attached to the free ends of resilient or elastic material sections 38 which, in turn, have the opposite ends attached to the outside surface of the suit or, specifically, to the outer tough layer 1 of the suit material. The resilient or elastic material sections 38 may be so small as to accommodate only one pulley or they may be large enough to have a group of pulleys fastened thereto. In either case these resilient or elastic material sections permit varied lateral movements of the pulleys to equalize the tension

of the suit on the wearer's body at various locations throughout the entire suit.

To serve as a protection to the suit contracting cables and associated pulleys and indicate their locations, the cover strips 39 are normally disposed over the courses of said cables. These cover strips are of a material the same as or similar to the outer layer of the suit material and each cover strip has one of its longitudinal edges, as 40, fixedly secured to the outer surface of the suit while the other longitudinal edge is temporarily secured in place by means of the elements of snap fasteners 41 so that said cover strips may be thrown back for access to the cables or pulleys.

A water-proof elastic material forms the collar 42 and seals the neck area of the suit when the adjacent placket opening is closed and a similar wrist band 43 is provided at the end of each sleeve but the latter must be sufficiently tight to prevent slipping as the suit contracting means is operated for contraction purposes.

The lower extremities of the leg portions are fashioned into foot formations to completely enclose the feet of the wearer and to give additional protection to the feet a unitary foot and heel tread element 44 of leather or any other suitable material is affixed to the sole surfaces of the foot portions of the suit legs.

From the foregoing it will be apparent that I have produced a highly efficient protective suit which will reduce to a minimum the possibility of injury to the wearer, one which will permit ventilation to any degree in accordance with climatic conditions, one which may be sealed manually when necessity arises and certain parts automatically sealed in case of accidental entrance into a body of water, one which can be contracted to make it form fitting and of proper size, and one which can be easily donned and opened along various areas for access to different parts of the body for any purpose, including the elimination of bodily waste.

Of course I do not wish to be limited to the exact details of construction herein shown and described as these may be varied within the scope of the appended claims without departing from the spirit of my invention.

Having described my invention what I claim as new and useful is:

1. A flexible shell suit fashioned to cover a wearer's body including the torso from the neck and the arms as far as the wrists, the legs and feet, the walls of said suit including an outer layer of flexible and water-proof elastomeric sheeting, an inner insulation layer of compressible airfoam latex material, a plurality of conical compressible mounds projecting from the inside surface of the inner insulation layer for coaction with a person's body to normally space said insulation layer from said body to provide an air chamber thereabout, and means to contract the suit walls about a wearer's body whereby to compress the mounds any desired degree to regulate the air chamber or finally substantially eliminate the air chamber.

2. The flexible shell suit according to claim 1 in combination with a plurality of suit contracting cables running in zig-zag fashion over pulleys arranged in courses extending along the anterior and posterior sides of the sleeves and over and around the trunk to the front center location on the waist and also extending along the anterior and posterior sides of the legs from adjacent the toe portions and heels, respectively, to said front center location on the waist, ratchet controlled reels having folding handles mounted on a stiff plate fixed to the exterior of the suit at said front center location on the waist to which certain of the cables are wound for contracting the suit when desired, covering strips imposed over the cables with one longitudinal edge of each strip fixed to the exterior of said suit, and means to temporarily attach the opposite longitudinal edge of each strip to the suit.

3. The structure according to claim 2 wherein the rollers are secured to resilient and flexible anchoring means fastened to the exterior of the suit.

4. The flexible shell suit according to claim 1 wherein the suit has a plurality of placket openings and a fly opening, a slide fastener to close each of said openings, the one at the fly opening having two slides, layers of material on opposite sides of each opening to cover the teeth of the slide fastener, a pair of coacting apertured flaps for each of said openings, one fixed at each side of each opening on the exterior of the suit, the meeting edges of said flaps being flexible whereby a cable for actuating the fastener slide may readily move between said flaps lengthwise thereof, an apertured spread stop of flexible and resilient material disposed across each of said openings, each spread stop fixed along one of its longitudinal edges to the inside of the suit at one side of each opening, means to temporarily attach the opposite longitudinal edge of each strip to the interior of the suit at the opposite side of each opening, a pair of parallel flexible apertured supports projecting from that side of the spread stop which is adapted to face a wearer's body, and a back stop of flexible, resilient and elastic material carried by said supports and adapted to seal the respective openings as the walls of the suit are moved close to the wearer's body, a number of compressible conical protuberances extending from that surface of the back stop which is adapted to face a wearer's body.

5. A flexible shell suit fashioned to cover a wearer's body including the torso between the neck and feet, the walls of said suit including an outer layer of tough flexible and water-proof elastomeric sheeting, an inner insulation layer of compressible airfoam latex material appreciably thicker than the outer layer, said suit walls having a plurality of placket openings located in various areas of the suit and a fly opening in the crotch, means to close said openings, a multiplicity of conical compressible mounds projecting from the inside surface of the inner layer of the suit walls and adapted to contact a wearer's body to normally hold the suit walls away from the wearer's body to provide an air chamber, said suit walls having inwardly tapered pore holes extending into the suit walls a distance less than the thickness thereof and each then divided into a plurality of oblique radial branches terminating at the tapered surface of a mound adjacent the base thereof to provide air passageways between the interior and exterior of the suit, and means to contract the suit walls whereby the mounds will be compressed any desired degree to regulate the capacity of and close the air passageways.

6. The flexible shell suit according to claim 5, in combination with a frusto-conical casing mounted in the tapered portion of each pore hole, a perforated cover mounted in the larger outer end of the casing, a perforated hollow stem extending from the center of the inner surface of

the cover and projecting towards the inner smaller end of said casing, an absorbent sponge material mounted in said stem and projecting from the free end thereof and shaped as a valve head, and a membrane covering said head, the expansion of the sponge material due to absorption of water causing the head to close the smaller end of the casing.

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