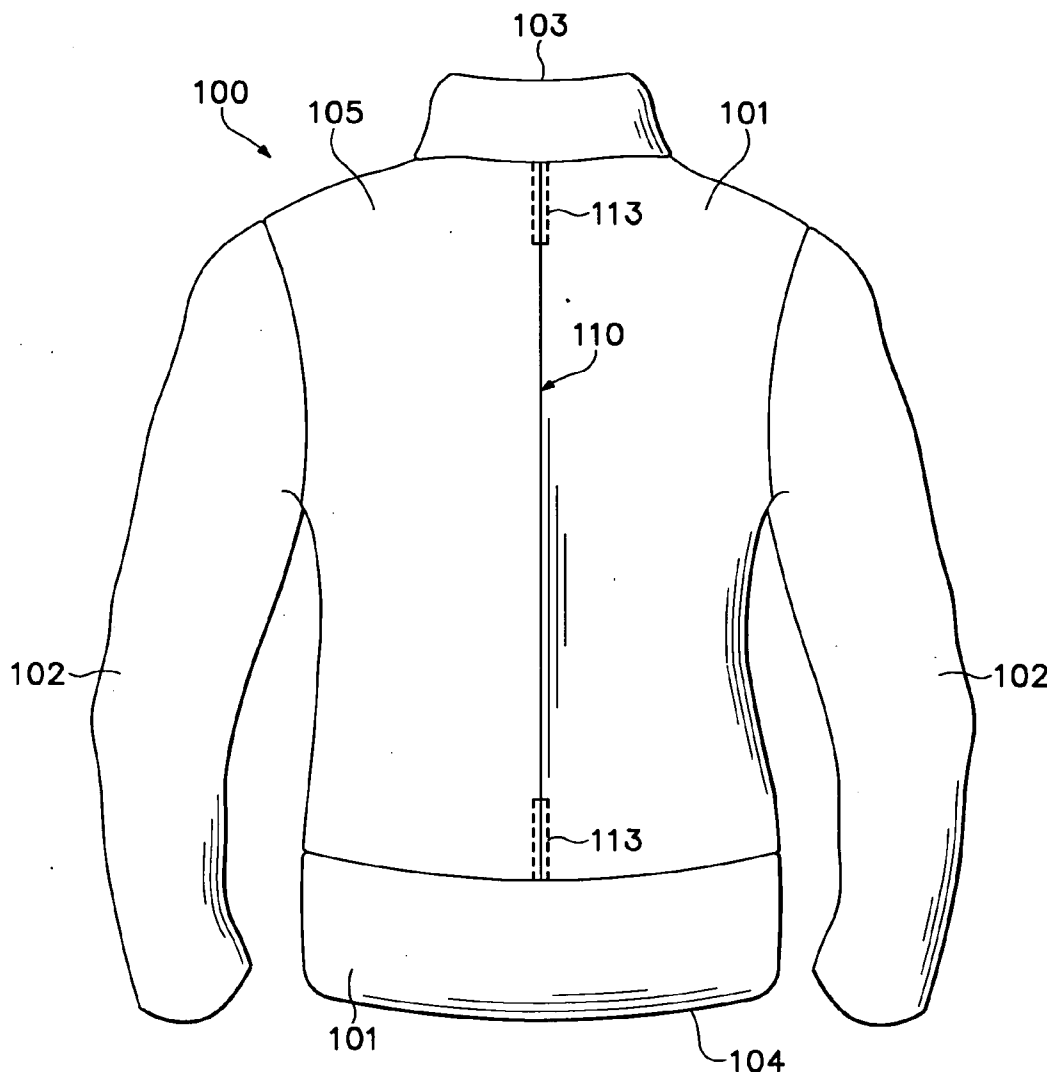




US 20060162050A1

(19) **United States**(12) **Patent Application Publication**
Kaufman et al.(10) **Pub. No.: US 2006/0162050 A1**(43) **Pub. Date: Jul. 27, 2006**(54) **ARTICLE OF APPAREL INCORPORATING A
PLEATED STRUCTURE****Publication Classification**(75) Inventors: **Rebecca A. Kaufman**, Lake Oswego,
OR (US); **David Matthew Litton**,
Portland, OR (US); **Rebecca Lynne**
Bilbaeno, Portland, OR (US); **Pamela**
Jean Stafford, Portland, OR (US)(51) **Int. Cl.**
A41B 11/00 (2006.01)
A43B 17/00 (2006.01)
A41D 27/08 (2006.01)
(52) **U.S. Cl.** 2/244Correspondence Address:
BANNER & WITCOFF, LTD.
1001 G STREET, N.W.
WASHINGTON, DC 20001-4597 (US)(73) Assignee: **NIKE, Inc.**, Beaverton, OR(21) Appl. No.: **11/042,312**(22) Filed: **Jan. 26, 2005**(57) **ABSTRACT**

Articles of apparel are disclosed that include one of a variety of pleated structures. In general, the pleated structures include a material element with one or more folds that place surfaces of the material element in an overlapping configuration. A bonding element is positioned between the overlapping surfaces and is bonded or otherwise secured to at least one of the overlapping surfaces. The bonding element may join the overlapping surfaces together, or the bonding element may be bonded to only one of the overlapping surfaces.



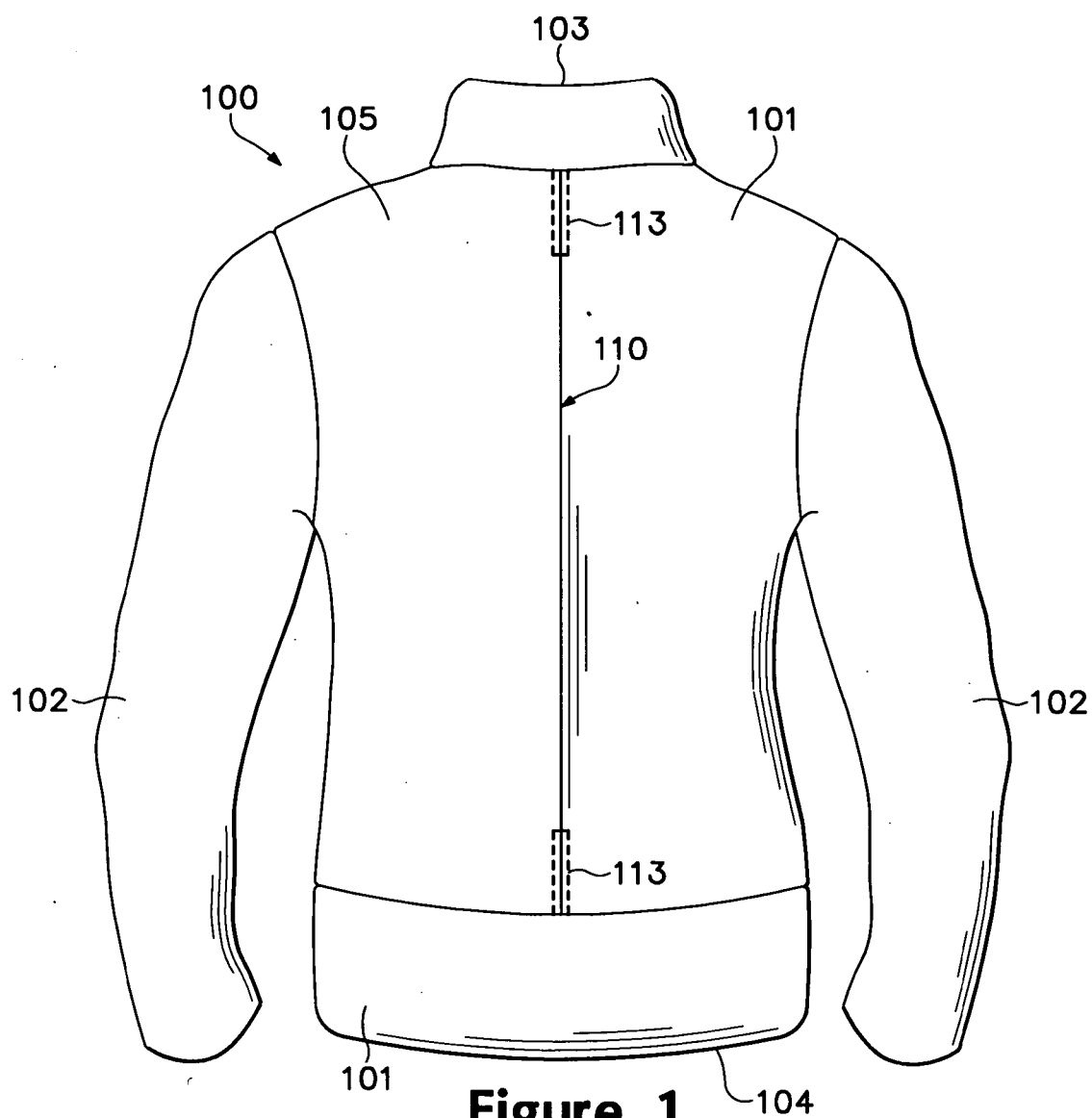


Figure 1

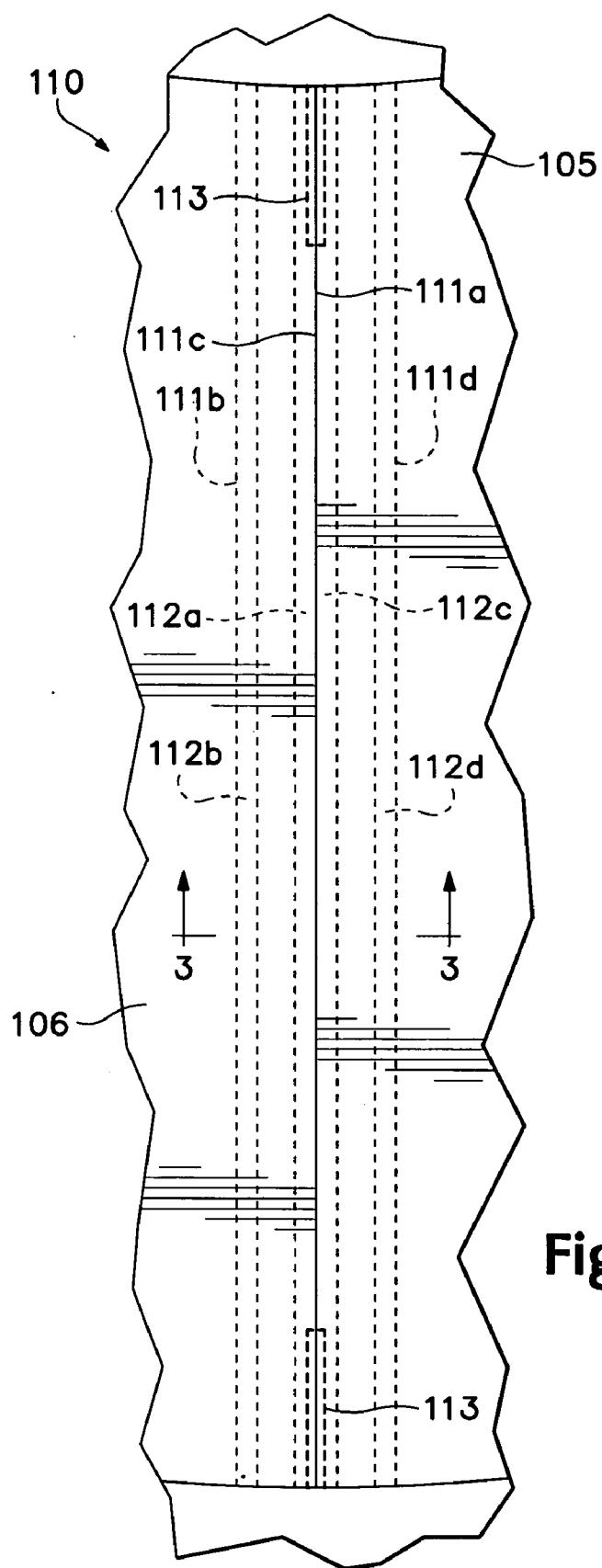
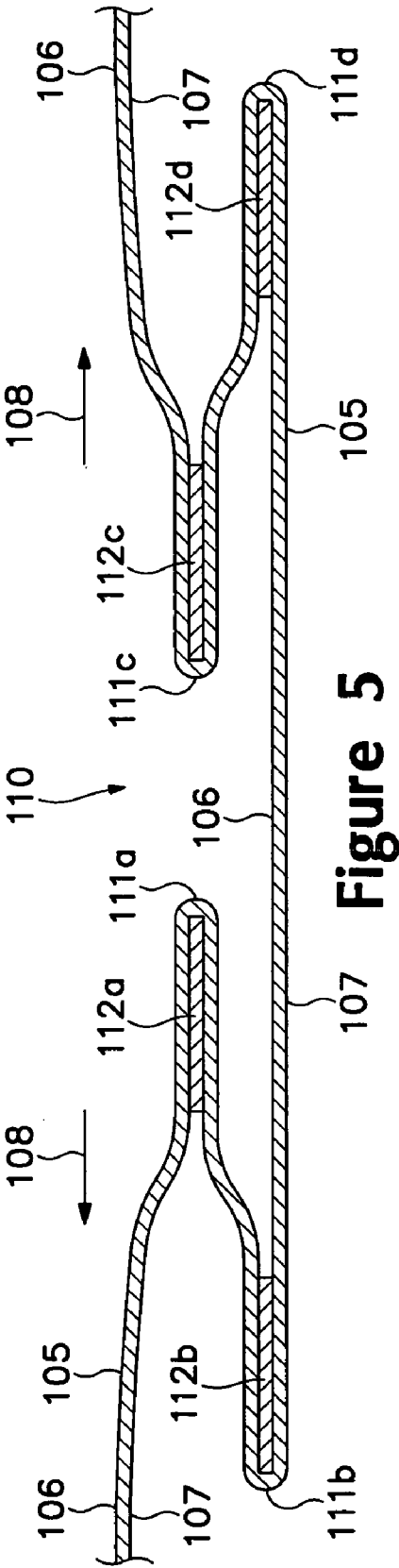
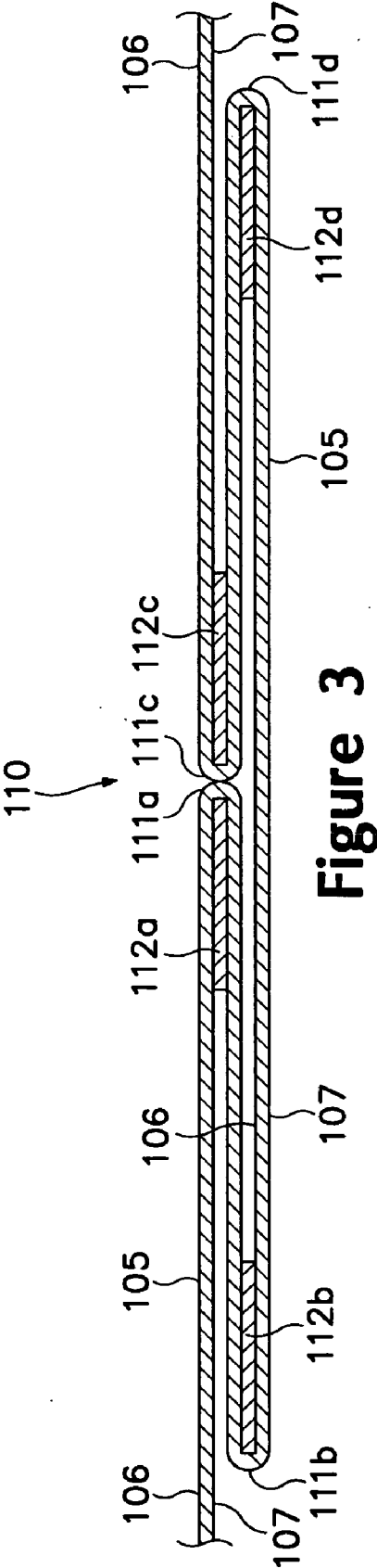


Figure 2



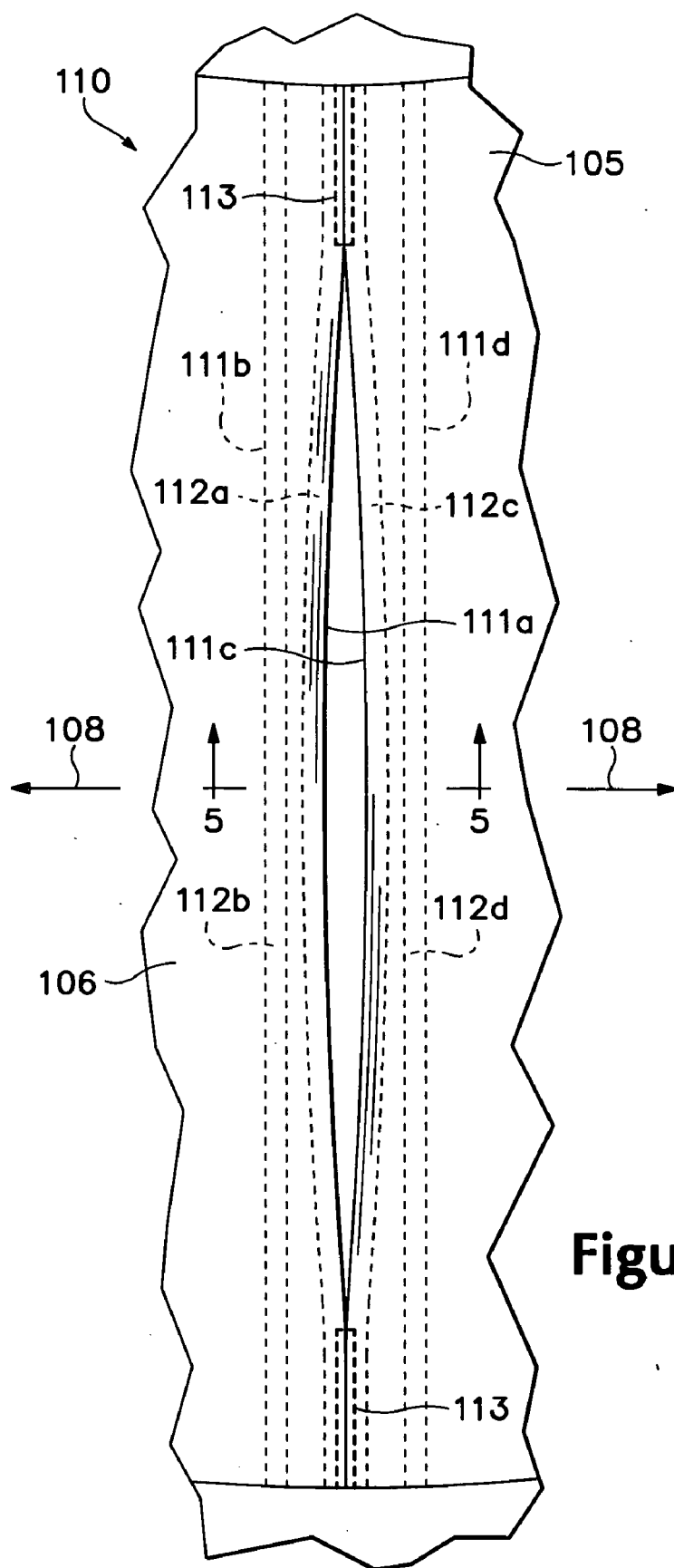


Figure 4

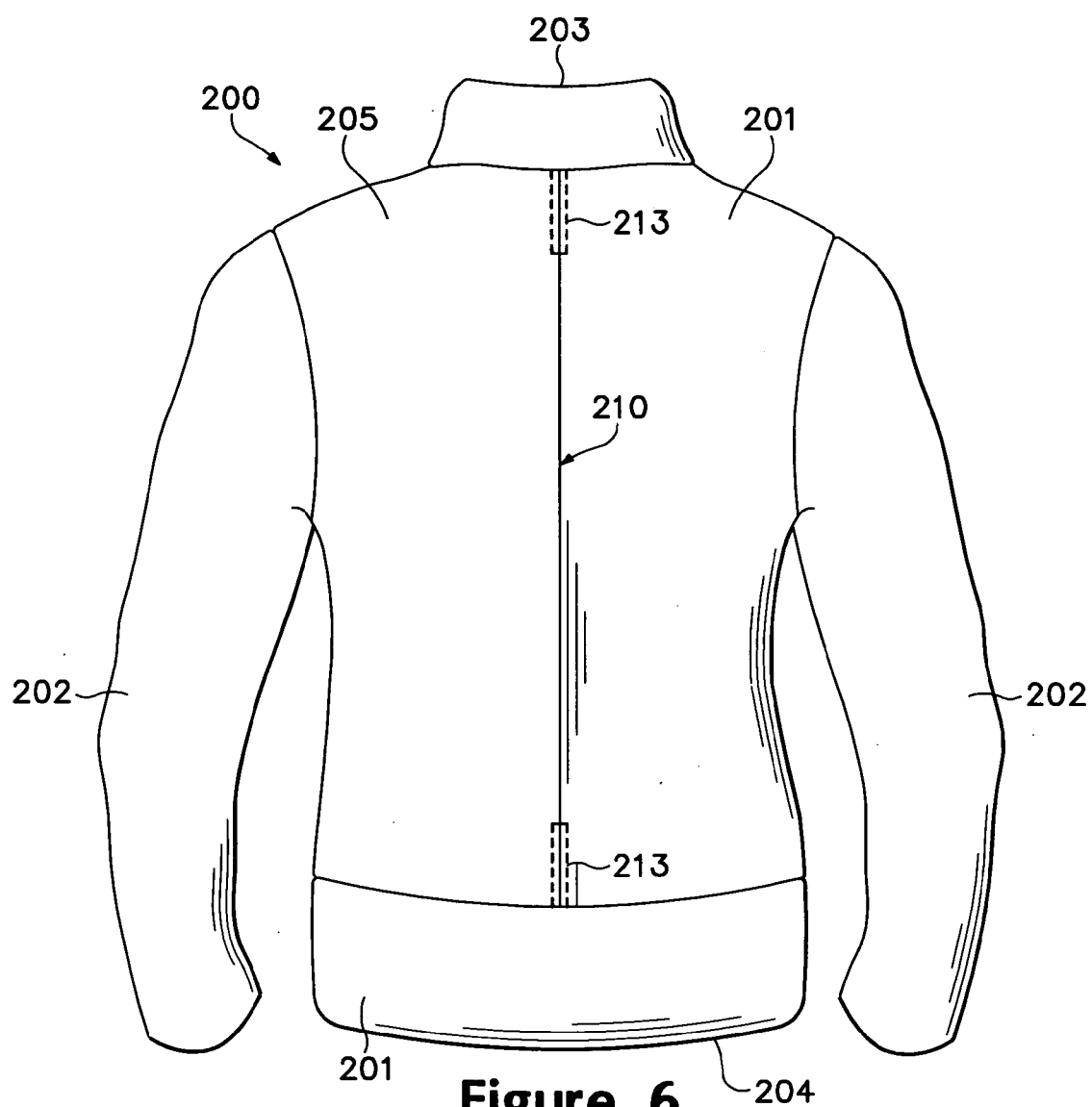


Figure 6

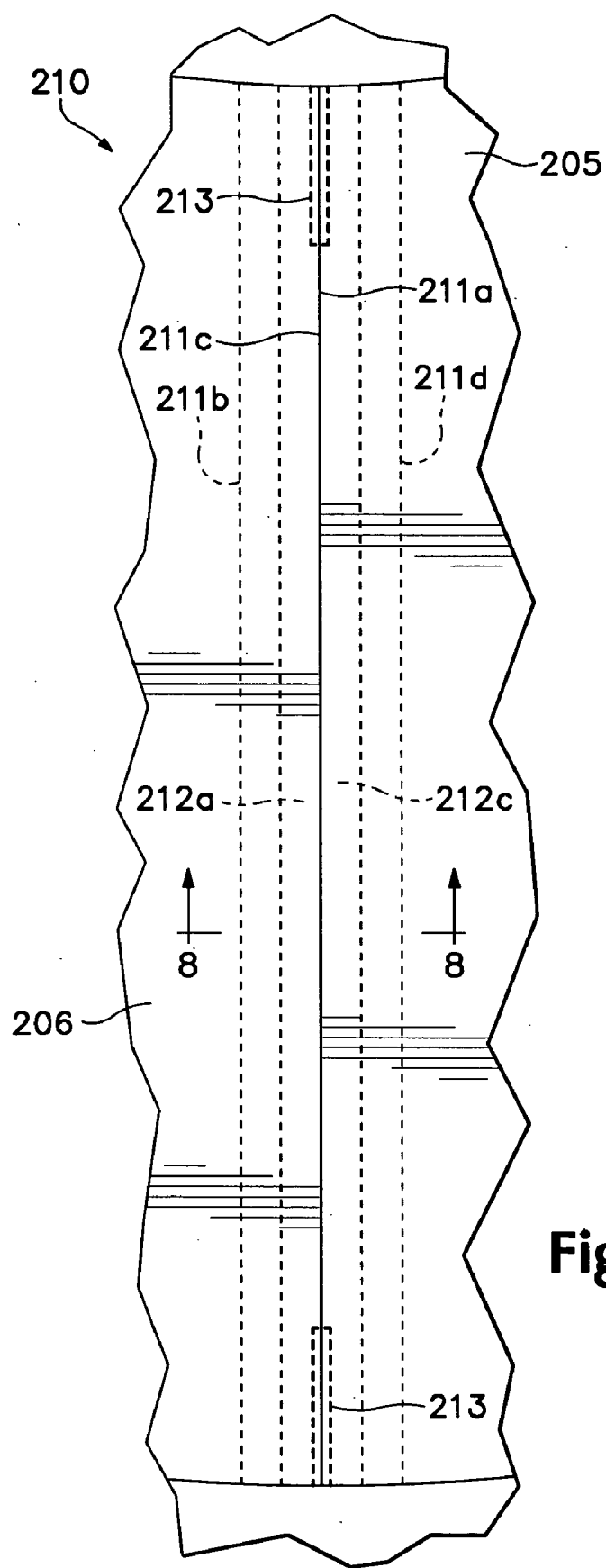
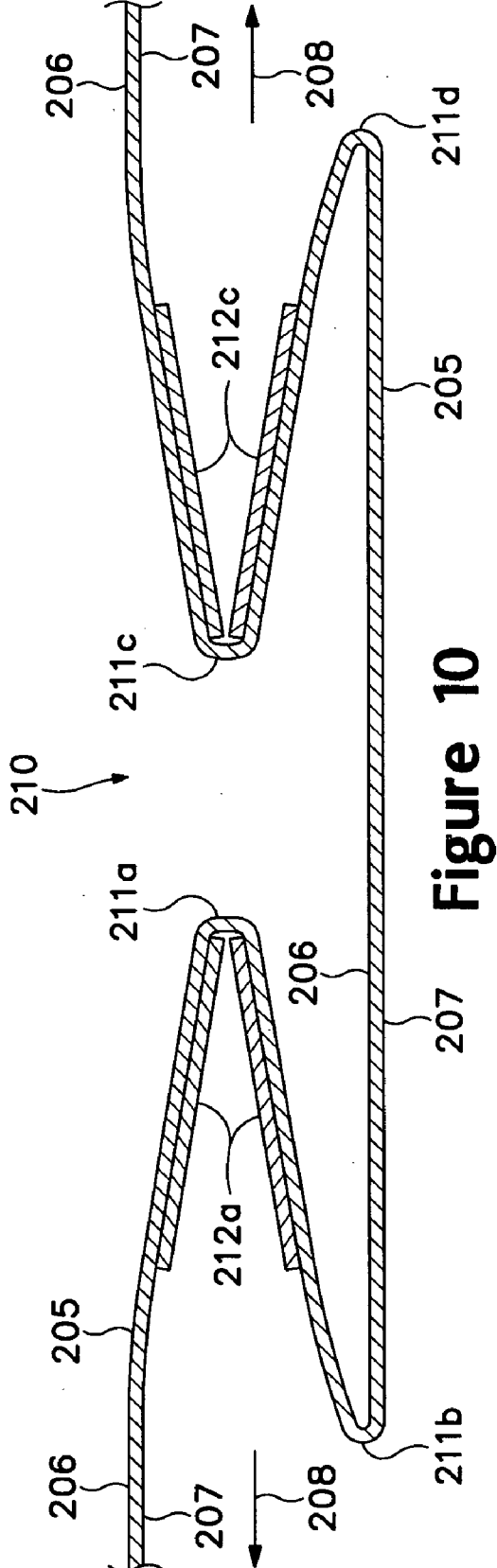
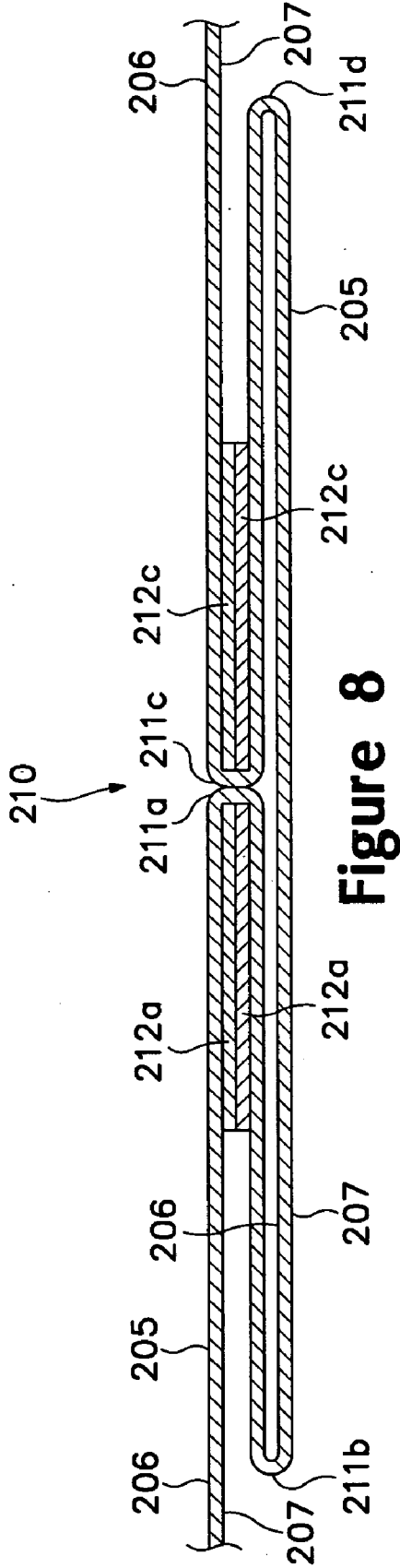


Figure 7



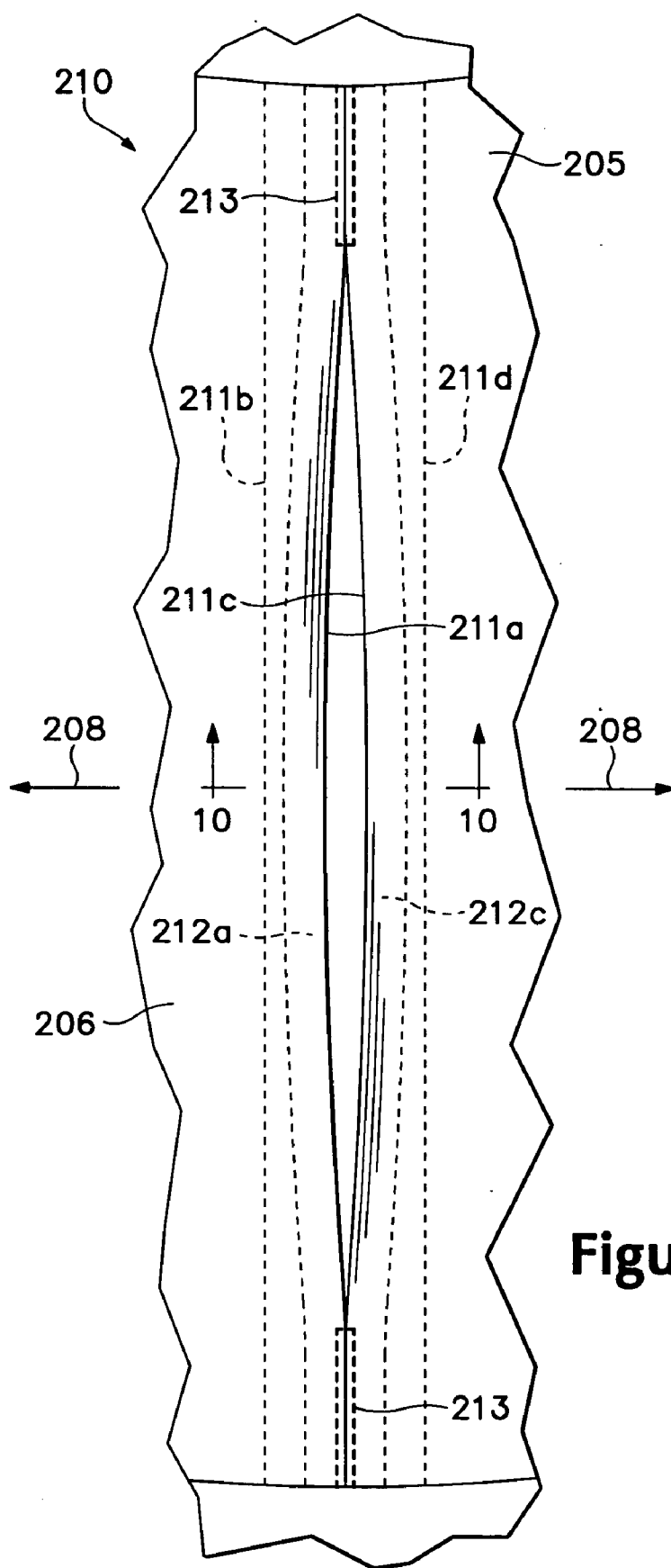


Figure 9

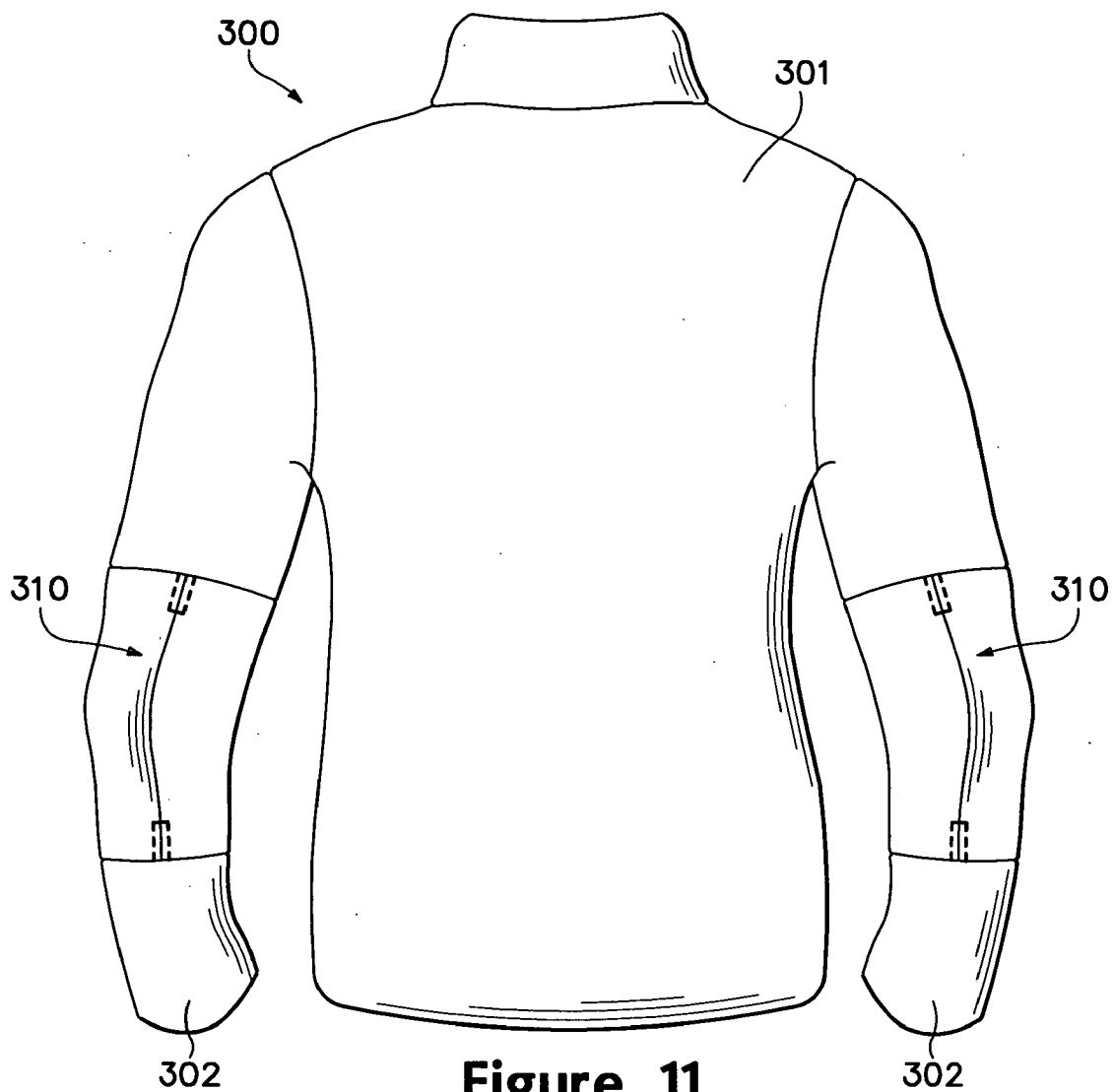


Figure 11

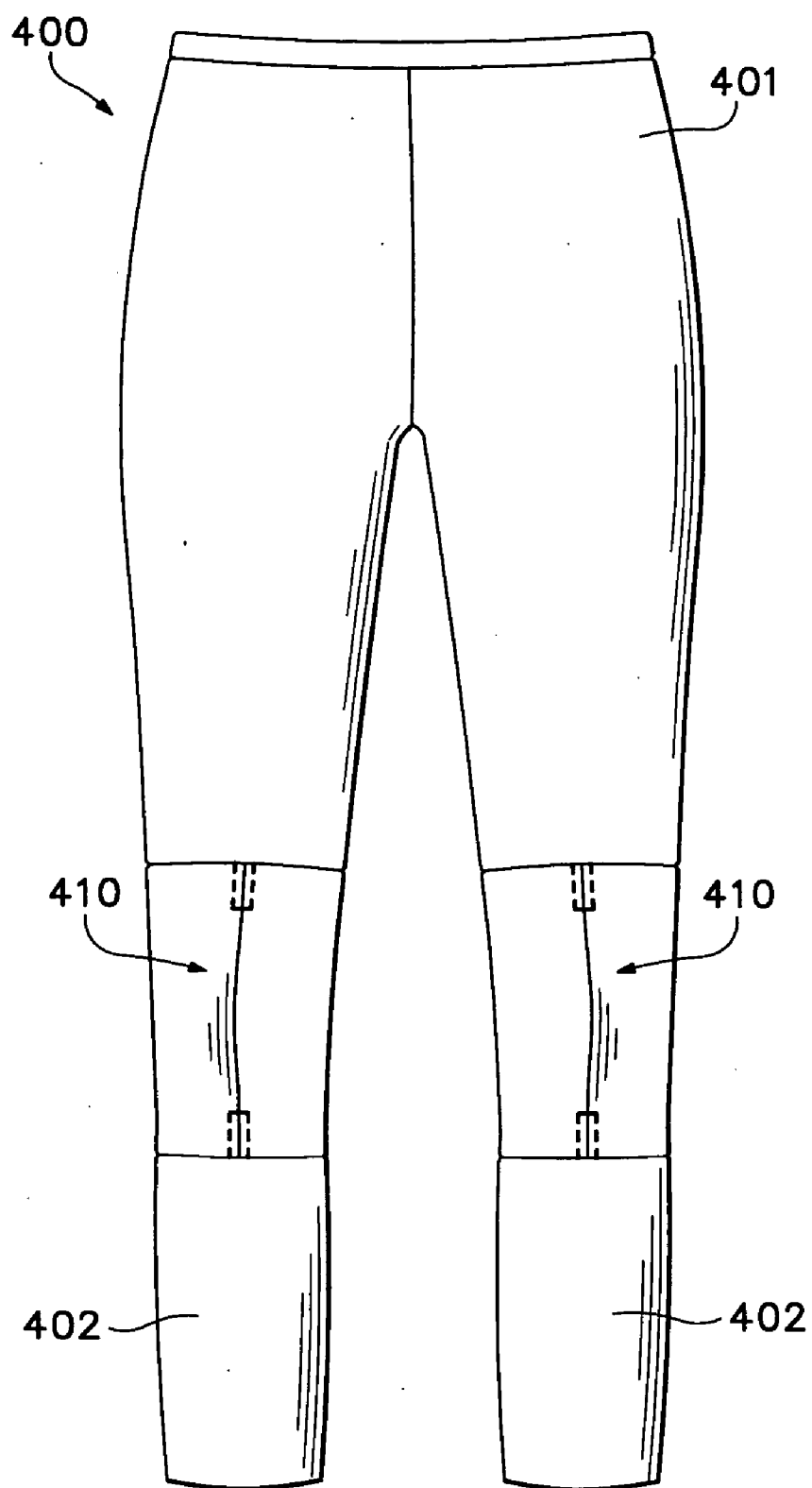


Figure 12

ARTICLE OF APPAREL INCORPORATING A PLEATED STRUCTURE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to apparel. The invention concerns, more particularly, an article of apparel that incorporates a pleated structure with secondary elements secured to and extending along at least one fold of the pleated structure. 2.

[0003] Description of Background Art

[0004] An article of apparel generally flexes, stretches, or otherwise deforms to accommodate movements of an individual wearing the article of apparel. Factors that contribute to the degree to which an article of apparel accommodates specific movements of the individual include the materials forming the article of apparel, the relative shapes of the article of apparel and the individual, and the various structural features incorporated into the article of apparel. Accordingly, the process of designing an article of apparel that accommodates specific movements of the individual involves considering each of these factors, as well as the intended use and desired aesthetics of the article of apparel.

[0005] Materials, relative shapes, and structural features cooperatively determine the degree to which an article of apparel accommodates movements of the individual. Many articles of apparel incorporate textiles, and the specific textile selected for a particular apparel application may be selected based upon the inherent drape and stretch properties of the textile, for example. In general, textiles with greater drape and stretch properties will accommodate the greatest range of motion in the individual. With regard to relative shapes, an article of apparel with dimensions that are similar to or greater than the dimensions of the individual will generally accommodate the greatest range of motion in the individual. Finally, structural features may also be utilized to enhance the degree to which an article of apparel accommodates movements of the individual. For example, articles of apparel may be designed to increase in length through an extension structure, as disclosed in U.S. Pat. No. 5,138,717 to Tolton. In addition, an article of apparel may be structured to effectively expand by incorporating pleated structures into defined areas of the article of apparel. Although materials, relative shapes, and structural features individually enhance the range of motion provided by an article of apparel, the process of designing an article of apparel generally involves considering the cooperative effect of various factors. That is, materials, relative shapes, and structural features cooperatively define the range of motion provided by an article of apparel.

[0006] The range of motion provided by an article of apparel is of particular interest to athletes when utilizing the article of apparel during athletic activities, whether practice or competition. For example, the game of golf requires that the arms of the individual freely move relative the torso of the individual, and that the torso rotate relative the legs of the individual. That is, an article of apparel, such as a shirt or jacket, that is suitable for the game of golf permits a wide range of motion in the upper body of the individual. Similarly, articles of apparel for sports such as running, biking, tennis, football, soccer, and baseball also permit a wide

range of motion in areas of the individual that are utilized during those particular athletic activities.

SUMMARY OF THE INVENTION

[0007] The present invention relates to an article of apparel having a pleated structure with a material element and a bonding element. The material element is formed from a two-dimensional material and has a first surface and an opposite second surface. The material element also has at least one fold. Portions of the first surface positioned adjacent to the fold and on opposite sides of the fold are placed in an overlapping configuration. The bonding element is secured to the first surface, and the bonding element is positioned adjacent to the fold and extends along the fold.

[0008] The two-dimensional material forming the material element may be a textile or polymer sheet, for example. One of the first surface and the second surface may form an exterior surface of the article of apparel, and another of the first surface and the second surface may form an interior surface of the article of apparel. In other embodiments, the fold may form a portion of a pleated structure in the article of apparel, and the pleated structure may be positioned in the article of apparel to extend along a back area of the torso region when worn.

[0009] The advantages and features of novelty characterizing the present invention are pointed out with particularity in the appended claims. To gain an improved understanding of the advantages and features of novelty, however, reference may be made to the following descriptive matter and accompanying drawings that describe and illustrate various embodiments and concepts related to the invention.

DESCRIPTION OF THE DRAWINGS

[0010] The foregoing Summary of the Invention, as well as the following Detailed Description of the Invention, will be better understood when read in conjunction with the accompanying drawings.

[0011] **FIG. 1** is a rear elevational view of an article of apparel having a first pleated structure in accordance with the present invention.

[0012] **FIG. 2** is a rear elevational view of the first pleated structure in a non-expanded configuration.

[0013] **FIG. 3** is a cross-sectional view of the first pleated structure in the non-expanded configuration, as defined by section line 3-3 in **FIG. 2**.

[0014] **FIG. 4** is a rear elevational view of the first pleated structure in an expanded configuration.

[0015] **FIG. 5** is a cross-sectional view of the first pleated structure in the expanded configuration, as defined by section line 5-5 in **FIG. 4**.

[0016] **FIG. 6** is a rear elevational view of an article of apparel having a second pleated structure in accordance with the present invention.

[0017] **FIG. 7** is a rear elevational view of the second pleated structure in a non-expanded configuration.

[0018] **FIG. 8** is a cross-sectional view of the second pleated structure in the non-expanded configuration, as defined by section line 8-8 in **FIG. 7**.

[0019] **FIG. 9** is a rear elevational view of the second pleated structure in an expanded configuration.

[0020] **FIG. 10** is a cross-sectional view of the second pleated structure in the expanded configuration, as defined by section line 10-10 in **FIG. 9**.

[0021] **FIG. 11** is a rear elevational view of another article of apparel incorporating either the first or second pleated structure.

[0022] **FIG. 12** is a front elevational view of yet another article of apparel incorporating either the first or second pleated structure.

DETAILED DESCRIPTION OF THE INVENTION

[0023] Introduction

[0024] The following discussion and accompanying figures disclose various articles of apparel that incorporate pleated structures in accordance with the present invention. Although the articles of apparel are depicted as being jackets and a pair of pants, the pleated structures may be incorporated into a variety of apparel types. More particularly, one or more of the pleated structures may be incorporated into headwear, short-sleeved shirts, long-sleeved shirts, suits, dresses, coats, vests, shorts, or skirts, for example. Additionally, one or more of the pleated structures may be incorporated into articles of apparel that are intended for use during casual wear or athletic activities. Accordingly, the jackets and pair of pants disclosed herein are intended to provide examples of the variety of apparel types that may incorporate the pleated structures.

[0025] First Pleat Configuration

[0026] With reference to **FIG. 1**, an article of apparel **100** incorporating a pleated structure **110** is disclosed. Article of apparel **100** includes a torso region **101** and a pair of arm regions **102**. In general, torso region **101** extends between a neck opening **103** and a waist opening **104** to cover a substantial portion of a torso of the wearer. Arm regions **102** extend outward from an upper area of torso region **101** and receive arms of the wearer. Pleated structure **110** extends in a generally vertical direction along a back area of torso region **101** and is depicted as extending through approximately three-quarters of the distance between neck opening **103** and waist opening **104**. In other embodiments, pleated structure **110** may extend through a lesser distance, or may extend entirely through the distance between neck opening **103** and waist opening **104**. Accordingly, the overall length of pleated structure **110** may vary significantly within the scope of the present invention.

[0027] Article of apparel **100** is a jacket having a configuration that is suitable for a variety of activities, including athletic activities associated with the game of golf. As discussed in the Background of the Invention section above, the game of golf requires that the arms of an individual freely move relative the torso of the individual, and also requires that the torso rotate relative the legs of the individual. That is, an article of apparel that is suitable for the game of golf permits a wide range of motion in the upper body of the individual. Pleated structure **110** enhances or otherwise increases the range of motion permitted by article of apparel **100**. More particularly, pleated structure **110**

changes from a non-expanded configuration to an expanded configuration upon the application of a generally horizontal tensile force in the back area of torso region **101**. This change from the non-expanded configuration to the expanded configuration increases the overall dimensions of torso region **101** and decreases the degree to which apparel **100** restricts motion of the individual.

[0028] Article of apparel **100** is formed from a plurality of flexible and generally two-dimensional material elements that are sewn, bonded, adhered, or otherwise joined together to form torso region **101** and arm regions **102**. Similarly, pleated structure **110** is formed from a plurality of flexible and generally two-dimensional material elements that are joined together. As utilized with respect to the present invention, the term "two-dimensional material" or variants thereof is intended to encompass generally flat materials exhibiting a length and a width that are substantially greater than a thickness. Accordingly, suitable materials for article of apparel **100** and pleated structure **110** include various textiles, polymer sheets, or combinations of textiles and polymer sheets, for example. Textiles are generally manufactured from fibers, filaments, or yarns that are, for example, either (a) produced directly from webs of fibers by bonding, fusing, or interlocking to construct non-woven fabrics and felts or (b) formed through a mechanical manipulation of yarn to produce a woven fabric. The textiles may incorporate fibers that are arranged to impart one-directional stretch or multi-directional stretch, and the textiles may include coatings that form a breathable and water-resistant barrier, for example. The polymer sheets may be extruded, rolled, or otherwise formed from a polymer material to exhibit a generally flat aspect. Two-dimensional materials may also encompass laminated or otherwise layered materials that include two or more layers of textiles, polymer sheets, or combinations of textiles and polymer sheets. In addition to textiles and polymer sheets, other two-dimensional materials may be incorporated into article of apparel **100** and pleated structure **110**.

[0029] Pleated structure **110** is defined in a two-dimensional material element **105** that forms at least a portion of the back area of torso region **101**, as depicted in **FIGS. 2 and 3**. Material element **105** includes an exterior surface **106** and an opposite interior surface **107**. Exterior surface **106** forms an exterior surface of article of apparel **100**. Similarly, interior surface **107** forms an interior surface of article of apparel **100**. Accordingly, material element **105** forms an exterior and interior surface of the back area of torso region **101**. In some embodiments, however, additional material elements may be coextensive with material element **105** such that the additional elements form one or both of the exterior or interior surfaces of article of apparel **100**.

[0030] Pleated structure **110** includes four folds **111a-111d**, four bonding elements **112a-112d**, and a pair of stitched areas **113**. Folds **111a-111d** are folded portions of material element **105** that are substantially parallel to each other and extend through the length of material element **105**. Bonding elements **112a-112d** are respectively positioned adjacent to folds **111a-111d** and bond overlapping surfaces of material element **105** to each other. Stitched areas **113** are located in upper and lower portions of pleated structure **110** and limit the degree to which the upper and lower portions may expand.

[0031] Pleated structure 110 is depicted in cross-section in FIG. 3 to illustrate the general construction of pleated structure 110, the configuration of folds 111a-111d, and the locations of bonding elements 112a-112d. With regard to fold 111a, material element 105 folds inward at fold 111a such that portions of interior surface 107 positioned adjacent to fold 111a and on opposite sides of fold 111a are placed in an overlapping configuration. That is, material element 105 is folded such that portions of interior surface 107 face each other along fold 111a. Bonding element 112a is positioned adjacent to fold 111a and extends along fold 111a. More particularly, bonding element 112a is positioned between the portions of interior surface 107 positioned adjacent to fold 111a, and bonding element 112a bonds these portions of interior surface 107 to each other.

[0032] With regard to fold 111b, material element 105 folds at fold 111a such that portions of exterior surface 106 positioned adjacent to fold 111b and on opposite sides of fold 111b are placed in an overlapping configuration. That is, material element 105 is folded such that portions of exterior surface 106 face each other along fold 111b. Bonding element 112b is positioned adjacent to fold 111b and extends along fold 111b. More particularly, bonding element 112b is positioned between the portions of exterior surface 106 positioned adjacent to fold 111b, and bonding element 112b bonds these portions of exterior surface 106 to each other.

[0033] Folds 111a and 111b effectively form a z-shaped configuration in pleated structure 110. With reference to FIG. 3, the portion of material element 105 that forms folds 111a and 111b defines three segments that are analogous to the three segments of the letter z. Accordingly, folds 111a and 111b cooperatively form a generally z-shaped configuration in pleated structure 110. Folds 111c and 111d effectively form a mirror image of folds 111a and 111b and define, therefore, a corresponding z-shaped configuration.

[0034] The configuration of folds 111c and 111d are substantially similar to the configuration of folds 111a and 111b. With regard to fold 111c, material element 105 folds inward at fold 111c such that portions of interior surface 107 positioned adjacent to fold 111c and on opposite sides of fold 111c are placed in an overlapping configuration. Bonding element 112c is positioned adjacent to fold 111c and extends along fold 111c. More particularly, bonding element 112c is positioned between the portions of interior surface 107 positioned adjacent to fold 111c, and bonding element 112c bonds these portions of interior surface 107 to each other.

[0035] With regard to fold 111d, material element 105 folds at fold 111d such that portions of exterior surface 106 positioned adjacent to fold 111d and on opposite sides of fold 111d are placed in an overlapping configuration. That is, material element 105 is folded such that portions of exterior surface 106 face each other along fold 111d. Bonding element 112d is positioned adjacent to fold 111d and extends along fold 111d. More particularly, bonding element 112d is positioned between the portions of exterior surface 106 positioned adjacent to fold 111d, and bonding element 112d bonds these portions of exterior surface 106 to each other.

[0036] Bonding elements 112a-112d may be a thermoplastic polymer, for example, that forms bonds with material element 105 through the application of sufficient heat and pressure, thereby bonding portions of the surfaces of material element 105 together. Alternately, bonding elements

112a-112d may be a material that forms the bonds through radio frequency or ultrasonic bonding processes, for example. In some embodiments, and as depicted in the figures, bonding elements 112a-112d are two-dimensional materials. With regard to the thermoplastic polymer, the amount of heat and pressure applied to form the bonds depends upon the specific material forming bonding elements 112a - 112d, which may be polyurethane, polyamide, polyester, polyolefin, or vinyl. Suitable thermoplastic polymers formed from these materials and having the configuration of a polymer tape may be supplied by Bemis Associates, Inc. of Shirley, Mass., United States. In general, the heat and pressure induces bonding elements 112a-112d to soften or melt so as to infiltrate the structure of material element 105. Upon subsequent cooling, bonding elements 112a-112d becomes securely bonded to portions of the surfaces of material element 105, thereby bonding the portions of the surfaces together without the necessity of stitching or other adhesive elements. A further benefit to the use of bonding elements 112a- 112d relates to the resulting configuration of the areas bonded by bonding elements 112a-112d. In general, bonding elements 112a-112d add little additional thickness to pleated structure 110 and permit the areas around folds 111a-111d to lie in a generally flat configuration.

[0037] Bonding elements 112a- 112d are discussed as being separate from material element 105 and bonded to material element 105. In some embodiments, bonding elements 112a-112d be portions of material element 105 that are bonded together through the application of heat and pressure, for example. That is, pleated structure 110 may be formed by bonding portions of material element 105 directly to each other, thereby negating the presence of separate bonding elements 112a-112d.

[0038] FIGS. 2 and 3 depict pleated structure 110 in the non-expanded configuration. During normal wear, pleated structure 110 will generally remain in the non-expanded configuration. As depicted in FIGS. 4 and 5, however, pleated structure 110 will change from the non-expanded configuration to the expanded configuration upon the application of a tensile force in the direction of arrows 108. This change from the non-expanded configuration to the expanded configuration increases the overall dimensions of torso region 101 and decreases the degree to which apparel 100 restricts motion of the individual.

[0039] In the non-expanded configuration, fold 111a is positioned immediately adjacent to fold 111c. In addition, the portions of material element 105 that extend between folds 111a and 111b and extend between folds 111c and 111d lie in a generally co-planar relationship with each other. In the expanded configuration, however, fold 111a is separated from fold 111c, and the portions of material element 105 that extend between folds 111a and 111b and extend between folds 111c and 111d bend or otherwise extend outward to accommodate the separation between folds 111a and 111c. That is, the tensile force in the direction of arrows 108 causes portions of material element 105 to bend or otherwise extend outward and form a separation between folds 111a and 111c, thereby increasing the overall dimensions of torso region 101 and decreasing the degree to which apparel 100 restricts motion of the individual.

[0040] Pleated structure 110 provides a combination of advantages that are suitable for a variety of apparel appli-

cations. As a first matter, pleated structure **110** readily converts from the non-expanded configuration to the expanded configuration upon the application of a force in the direction of arrows **108**, thereby increasing the overall dimensions of torso region **101** and decreasing the degree to which apparel **100** restricts motion of the individual. When the tensile force is removed or lessened, however, pleated structure **110** readily returns to the non-expanded configuration. More particularly, the configuration of folds **11a-11d** and the use of bonding elements **112a-112d** imparts a tendency in pleated structure **110** to return to the non-expanded configuration. As another matter, pleated structure **110** forms a low-profile element of article of apparel **100**. In the non-expanded configuration, bonding elements **112a-112d** align the various segments of material element **105** along the direction of arrows **108**. That is, material element **105** has a relatively planar configuration that does not add significant bulk to article of apparel **100** when in the non-expanded configuration. Pleated structure **110** is, therefore, a relatively inconspicuous element of article of apparel **100** and is suitable for apparel where aesthetics are considered during the design process.

[0041] Second Pleat Configuration

[0042] With reference to **FIG. 6**, an article of apparel **200** incorporating a pleated structure **210** is disclosed. Article of apparel **200** exhibits a configuration that is similar to article of apparel **100** and includes a torso region **201** and a pair of arm regions **202**. In addition, article of apparel **200** is a jacket having a configuration that is suitable for a variety of activities, including athletic activities associated with the game of golf. Pleated structure **210** enhances or otherwise increases the range of motion permitted by article of apparel **200**. More particularly, pleated structure **210** changes from a non-expanded configuration to an expanded configuration upon the application of a generally horizontal tensile force in the back area of torso region **201**. This change from the non-expanded configuration to the expanded configuration increases the overall dimensions of torso region **201** and decreases the degree to which apparel **200** restricts motion of the individual. Accordingly, pleated structure **210** provides advantages that are similar to the advantages discussed above with respect to pleated structure **110**.

[0043] Article of apparel **200** is formed from a plurality of flexible and generally two-dimensional material elements that are sewn, bonded, adhered, or otherwise joined together to form torso region **201** and arm regions **202**. Similarly, pleated structure **210** is formed from a plurality of flexible and generally two-dimensional material elements that are joined together. Pleated structure **210** is defined in a two-dimensional material element **205** that forms at least a portion of the back area of torso region **201**, as depicted in **FIGS. 7 and 8**. Material element **205** includes an exterior surface **206** and an opposite interior surface **207**. Exterior surface **206** forms an exterior surface of article of apparel **200**. Similarly, interior surface **207** forms an interior surface of article of apparel **200**. Accordingly, material element **205** forms an exterior and interior surface of the back area of torso region **201**. In some embodiments, however, additional material elements may be coextensive with material element **205** such that the additional elements form one or both of the exterior or interior surfaces of article of apparel **200**.

[0044] Pleated structure **210** includes four folds **211a-211d**, two bonding elements **212a**, two bonding elements

212c, and a pair of stitched areas **213**. Folds **211a-211d** are folded portions of material element **205** that are substantially parallel to each other and extend through the length of material element **205**. Bonding elements **212a** are positioned adjacent to fold **211a**, and bonding elements **212c** are positioned adjacent to fold **211c**. Stitched areas **213** are located in upper and lower portions of pleated structure **210** and limit the degree to which the upper and lower portions may expand.

[0045] Pleated structure **210** is depicted in cross-section in **FIG. 8** to illustrate the general construction of pleated structure **210**, the configuration of folds **211a-211d**, and the locations of bonding elements **212a** and **212c**. With regard to fold **211a**, material element **205** folds inward at fold **211a** such that portions of interior surface **207** positioned adjacent to fold **211a** and on opposite sides of fold **211a** are placed in an overlapping configuration. That is, material element **205** is folded such that portions of interior surface **207** face each other along fold **211a**. Bonding elements **212a** are positioned adjacent to fold **211a**, on opposite sides of fold **211a**, and are secured to interior surface **207** along fold **211a**. More particularly, bonding elements **212a** are separately secured to interior surface **207** and positioned adjacent to opposite sides of fold **211a**. Unlike bonding element **112a**, however, bonding elements **212a** do not bond portions of interior surface **207** to each other. Rather, only one surface of bonding elements **212a** is bonded to interior surface **207**.

[0046] With regard to fold **211b**, material element **205** folds at fold **211b** such that portions of exterior surface **206** positioned adjacent to fold **211b** and on opposite sides of fold **211b** are placed in an overlapping configuration. That is, material element **205** is folded such that portions of exterior surface **206** face each other along fold **211b**. Unlike pleated element **110**, no bonding element is positioned adjacent to fold **211b** in this embodiment. In some embodiments, however, one or more bonding elements may be secured to material element **205** adjacent to fold **211b**.

[0047] Folds **211a** and **211b** effectively form a z-shaped configuration in pleated structure **210**. With reference to **FIG. 8**, the portion of material element **205** that forms folds **211a** and **211b** defines three segments that are analogous to the three segments of the letter z. Accordingly, folds **211a** and **211b** cooperatively form a generally z-shaped configuration in pleated structure **210**. Folds **211c** and **211d** effectively form a mirror image of folds **211a** and **211b** and define, therefore, a corresponding z-shaped configuration.

[0048] The configuration of folds **211c** and **211d** are substantially similar to the configuration of folds **211a** and **211b**. With regard to fold **211c**, material element **205** folds inward at fold **211c** such that portions of interior surface **207** positioned adjacent to fold **211c** and on opposite sides of fold **211c** are placed in an overlapping configuration. That is, material element **205** is folded such that portions of interior surface **207** face each other along fold **211c**. Bonding elements **212c** are positioned adjacent to fold **211c**, on opposite sides of fold **211c**, and are secured to interior surface **207** along fold **211c**. More particularly, bonding elements **212c** are separately secured to interior surface **207** and positioned adjacent to opposite sides of fold **211c**. Unlike bonding element **112c**, however, bonding elements **212c** do not bond portions of interior surface **207** to each other. Rather, only one surface of bonding elements **212c** is bonded to interior surface **207**.

[0049] With regard to fold **211d**, material element **205** folds at fold **211d** such that portions of exterior surface **206** positioned adjacent to fold **211d** and on opposite sides of fold **211d** are placed in an overlapping configuration. That is, material element **205** is folded such that portions of exterior surface **206** face each other along fold **211d**. Unlike pleated element **110**, no bonding element is positioned adjacent to fold **211d** in this embodiment. In some embodiments, however, one or more bonding elements may be secured to material element **205** adjacent to fold **211d**.

[0050] The materials forming bonding elements **212a** and **212c** may be similar to the materials that form bonding elements **112a-112d**. As an alternative, bonding elements **212a** and **212c** may be formed from a material that is substantially similar to the material forming material element **205**, and bonding elements **212a** and **212c** may include a thermoplastic material on one surface that effectively bonds or otherwise secures the material to interior surface **207**. That is, bonding elements **212a** and **212c** may be formed from the same material as other portions of article of apparel **200**, and bonding elements **212a** and **212c** may include another material that secures bonding elements **212a** and **212c** to interior surface **207**.

[0051] FIGS. 7 and 8 depict pleated structure **210** in the non-expanded configuration. During normal wear, pleated structure **210** will generally remain in the non-expanded configuration. As depicted in FIGS. 9 and 10, however, pleated structure **210** will change from the non-expanded configuration to the expanded configuration upon the application of a tensile force in the direction of arrows **208**. This change from the non-expanded configuration to the expanded configuration increases the overall dimensions of torso region **201** and decreases the degree to which apparel **200** restricts motion of the individual.

[0052] In the non-expanded configuration, fold **211a** is positioned immediately adjacent to fold **211c**. In addition, the portions of material element **205** that extend between folds **211a** and **211b** and extend between folds **211c** and **211d** lie in a generally co-planar relationship with each other. In the expanded configuration, however, fold **211a** is separated from fold **211c**, and the portions of material element **205** that extend between folds **211a** and **211b** and extend between folds **211c** and **211d** bend or otherwise extend outward to accommodate the separation between folds **211a** and **211c**. That is, the tensile force in the direction of arrows **208** causes portions of material element **205** to bend or otherwise extend outward and form a separation between folds **211a** and **211c**, thereby increasing the overall dimensions of torso region **201** and decreasing the degree to which apparel **200** restricts motion of the individual.

[0053] Pleated structure **210** provides a combination of advantages that are suitable for a variety of apparel applications. As a first matter, pleated structure **210** readily converts from the non-expanded configuration to the expanded configuration upon the application of a force in the direction of arrows **208**, thereby increasing the overall dimensions of torso region **201** and decreasing the degree to which apparel **200** restricts motion of the individual. When the tensile force is removed or lessened, however, pleated structure **210** readily returns to the non-expanded configuration. More particularly, the configuration of folds **211a-211d** and the use of bonding elements **212a-212d** imparts a

tendency in pleated structure **210** to return to the non-expanded configuration. As another matter, pleated structure **210** forms a low-profile element of article of apparel **200**. In the non-expanded configuration, bonding elements **212a-212d** align the various segments of material element **205** along the direction of arrows **208**. That is, material element **205** has a relatively planar configuration that does not add significant bulk to article of apparel **200** when in the non-expanded configuration. Pleated structure **210** is, therefore, a relatively inconspicuous element of article of apparel **200** and is suitable for apparel where aesthetics are considered during the design process.

[0054] In pleated structure **210**, the pair of bonding elements **212a** are positioned adjacent and on opposite sides of fold **211a**, and the pair of bonding elements **212c** are positioned adjacent and on opposite sides of fold **211c**. As an alternative to the configuration discussed above, the pair of bonding elements **212a** may be replaced by a single bonding element that is centered over fold **211a** and also folded with fold **211a**. That is, the space between bonding elements **212a** may be eliminated such that a single bonding element is secured to interior surface **207** and folded at fold **211a**. Similarly, the pair of bonding elements **212c** may be replaced by a single bonding element that is centered over fold **211c** and also folded with fold **211c**. Upon the application of heat and pressure, for example, the single bonding elements may form a defined and crisp fold at each of folds **211a** and **211c**. In a similar manner, each of bonding elements **112a-112d** may be centered over folds **111a-111d**, folded with folds **111a-111d**, and bonded to effectively form a structure that is identical to pleated structure **110**.

[0055] Additional Apparel Configurations

[0056] Pleated structures **110** and **210** are discussed above and depicted in the figures as being located in a back area of either torso region **101** or torso region **201**. This configuration increases the overall dimensions of torso regions **101** and **201** in response to a tensile force. In further embodiments of the invention, either of pleated structures **110** and **210** may be located in other portions of an article of apparel. For example, either of pleated structures **110** and **210** may be located in a front area of the apparel, or a pair of pleated structures having the configuration of either of pleated structures **110** and **210** may be located on opposite side areas of the apparel.

[0057] With reference to FIG. 11, an article of apparel **300** having a torso region **301** and a pair of arm regions **302** is depicted. A pleated structure **310**, which is similar in configuration to either of pleated structures **110** and **210**, is located in elbow areas of each arm region **302**. During movements or bending of the arms, each of pleated structures **310** may expand to increase the overall dimensions of arm regions **302** and decrease the degree to which apparel **300** restricts motion of the individual. Accordingly, structures having the general configuration of pleated structures **110** and **210** may be incorporated into a variety of areas of an article of apparel. As another example, an article of apparel **400** having the configuration of a pair of pants with a pelvic region **401** and a pair of leg regions **402** is depicted in FIG. 12. A pleated structure **410**, which is similar in configuration to either of pleated structures **110** and **210**, is located in knee areas of each leg region **402**. During movements or bending of the legs, each of pleated structures

410 may expand to increase the overall dimensions of leg regions **402** and decrease the degree to which apparel **400** restricts motion of the individual. Accordingly, structure having the general configuration of pleated structures **110** and **210** may be incorporated into a variety of areas of an article of apparel and into a variety of apparel types.

[0058] Conclusion

[0059] The present invention is disclosed above and in the accompanying drawings with reference to a variety of embodiments. The purpose served by the disclosure, however, is to provide an example of the various features and concepts related to the invention, not to limit the scope of the invention. One skilled in the relevant art will recognize that numerous variations and modifications may be made to the embodiments described above without departing from the scope of the present invention, as defined by the appended claims.

That which is claimed is:

1. An article of apparel having a pleated structure, the pleated structure comprising:

a primary element formed from a two-dimensional material, the primary element having a first surface and an opposite second surface, and the primary element having at least a first fold and a second fold that form a z-shaped configuration in cross-section, portions of the first surface positioned adjacent to the first fold and on opposite sides of the first fold being placed in an overlapping configuration, and portions of the second surface positioned adjacent to the second fold and on opposite sides of the second fold being placed in an overlapping configuration; and

a secondary element secured to the first surface, the secondary element being positioned adjacent to the first fold and extending along the first fold, wherein one of the first surface and the second surface form an exterior surface of the article of apparel, and another of the first surface and the second surface form an interior surface of the article of apparel.

2. The article of apparel recited in claim 1, wherein the secondary element secures the portions of the first surface positioned adjacent to the first fold to each other.

3. The article of apparel recited in claim 2, wherein the secondary element is a polymer tape bonded to the portions of the first surface positioned adjacent to the first fold.

4. The article of apparel recited in claim 2, wherein the pleated structure includes another secondary element that is secured to the second surface, positioned adjacent to the second fold, and extending along the second fold, the another secondary element securing the portions of the second surface positioned adjacent to the second fold to each other.

5. The article of apparel recited in claim 1, wherein the first fold and the second fold are substantially parallel to each other.

6. The article of apparel recited in claim 1, wherein the pleated structure includes a third fold and a fourth fold that form another z-shaped configuration in cross-section, and the pleated structure includes another secondary element that is secured to the first surface, the another secondary element being positioned adjacent to the third fold and extending along the third fold.

7. The article of apparel recited in claim 1, wherein the pleated structure extends along a back area of a torso region of the article of apparel.

8. The article of apparel recited in claim 1, wherein the secondary element is formed from a two-dimensional material.

9. An article of apparel for covering a torso region of a wearer, the article of apparel comprising:

a primary element formed from a two-dimensional material, the primary element having a first surface and an opposite second surface, and the primary element having at least a first fold and a second fold that form a z-shaped configuration in cross-section, portions of the first surface positioned adjacent to the first fold and on opposite sides of the first fold being placed in an overlapping configuration, and portions of the second surface positioned adjacent to the second fold and on opposite sides of the second fold being placed in an overlapping configuration; and

a secondary element secured to the first surface, the secondary element being positioned adjacent to the first fold and extending along the first fold,

wherein the first fold and the second fold form a pleated structure in the article of apparel, and the pleated structure is positioned in the article of apparel to extend along a back area of the torso region when worn.

10. The article of apparel recited in claim 9, wherein the secondary element secures the portions of the first surface positioned adjacent to the first fold to each other.

11. The article of apparel recited in claim 10, wherein the secondary element is a polymer tape bonded to the portions of the first surface positioned adjacent to the first fold.

12. The article of apparel recited in claim 10, wherein the pleated structure includes another secondary element that is secured to the second surface, positioned adjacent to the second fold, and extending along the second fold, the another secondary element securing the portions of the second surface positioned adjacent to the second fold to each other.

13. The article of apparel recited in claim 9, wherein the pleated structure extends vertically along a center of the back area.

14. The article of apparel recited in claim 9, wherein the first fold and the second fold are substantially parallel to each other.

15. The article of apparel recited in claim 9, wherein the pleated structure includes a third fold and a fourth fold that form another z-shaped configuration in cross-section, and the pleated structure includes another secondary element that is secured to the first surface, the another secondary element being positioned adjacent to the third fold and extending along the third fold.

16. The article of apparel recited in claim 9, wherein the secondary element is formed from a two-dimensional material.

17. An article of apparel comprising:

a material element formed from a two-dimensional material, the material element having at least four folds that define four overlapping areas; and

at least four bonding elements positioned adjacent to the four folds and between the four overlapping areas, the bonding elements bonding opposite sides of the overlapping areas to each other.

18. The article of apparel recited in claim 17, wherein a first surface of the material element forms an exterior surface of the article of apparel, and a second surface of the material element forms an interior surface of the article of apparel.

19. The article of apparel recited in claim 17, wherein the bonding elements are sections of a polymer tape that are bonded to the opposite sides of the overlapping areas.

20. The article of apparel recited in claim 17, wherein the material element and the bonding elements are located in a back area of a torso region of the article of apparel.

21. The article of apparel recited in claim 17, wherein the bonding elements are formed from a two-dimensional material.

22. An article of apparel comprising:

a material element formed from a two-dimensional material, the material element having at least four folds that define four overlapping areas; and

at least four bonding elements formed from a two-dimensional material and positioned adjacent to the four folds and between the four overlapping areas, the bonding elements bonding opposite sides of the overlapping areas to each other,

wherein a first surface of the material element forms an exterior surface of the article of apparel, and a second surface of the material element forms an interior surface of the article of apparel, and the four folds are positioned in the article of apparel to extend along a center of a back area of the torso region when worn.

23. The article of apparel recited in claim 22, wherein the bonding elements are sections of a polymer tape that are bonded to the opposite sides of the overlapping areas.

* * * * *