



US 20180146721A1

(19) **United States**

(12) **Patent Application Publication**

Aherne, III et al.

(10) **Pub. No.: US 2018/0146721 A1**

(43) **Pub. Date: May 31, 2018**

(54) **MATERIAL HAVING AN EXPANDABLE PORTION**

Publication Classification

(71) Applicants: **William Edward Aherne, III**,
Annapolis, MD (US); **Adam Freund**,
Groveland, CA (US)

(51) **Int. Cl.**
A41D 13/002 (2006.01)
A47G 25/90 (2006.01)
(52) **U.S. Cl.**
CPC *A41D 13/0025* (2013.01); *A47G 25/90*
(2013.01)

(72) Inventors: **William Edward Aherne, III**,
Annapolis, MD (US); **Adam Freund**,
Groveland, CA (US)

(57) **ABSTRACT**

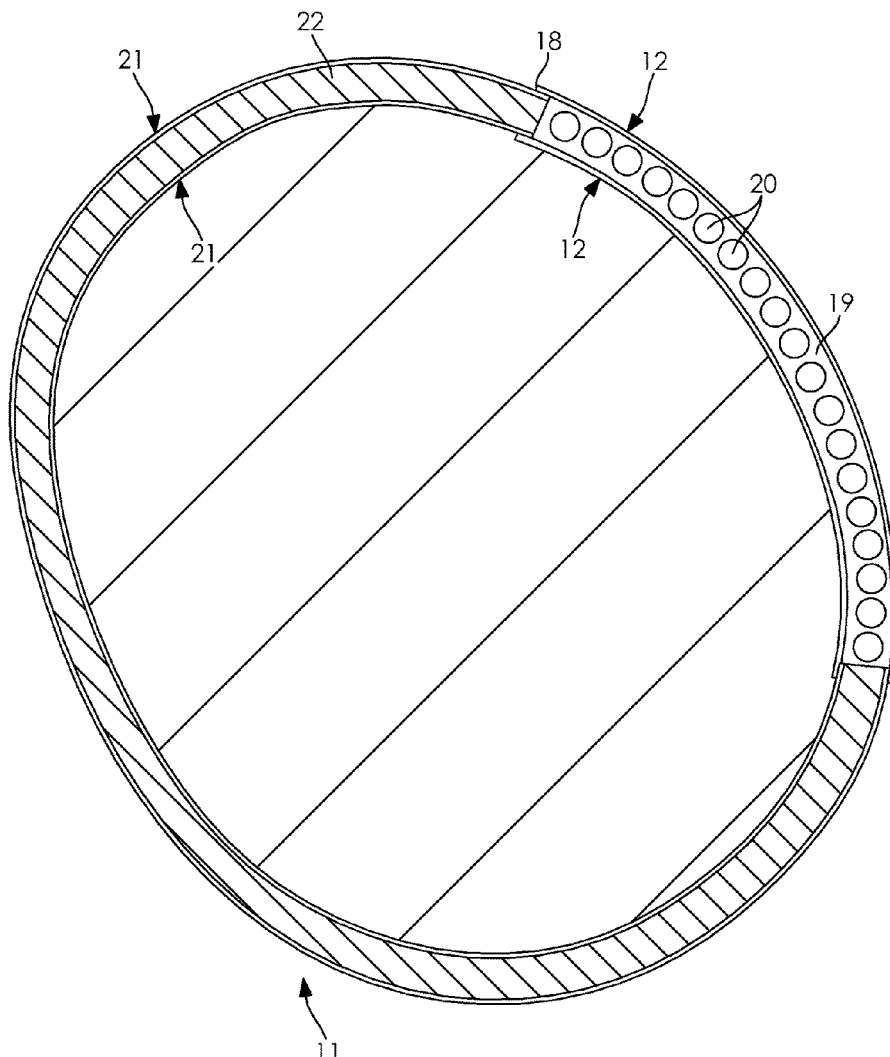
(21) Appl. No.: **15/823,235**

An article of apparel is disclosed. The article of apparel has a first portion that extends in a longitudinal direction of the article of apparel and a second portion that extends in the longitudinal direction. The second portion is attached to the first portion. The second portion is more expandable than the first portion. The second portion is expandable in both the longitudinal direction and in a transverse direction that is perpendicular to the longitudinal direction. The second portion is more expandable in the longitudinal direction in which the first portion and the second portion extend than in the transverse direction that is perpendicular to the longitudinal direction.

(22) Filed: **Nov. 27, 2017**

Related U.S. Application Data

(60) Provisional application No. 62/426,712, filed on Nov. 28, 2016.



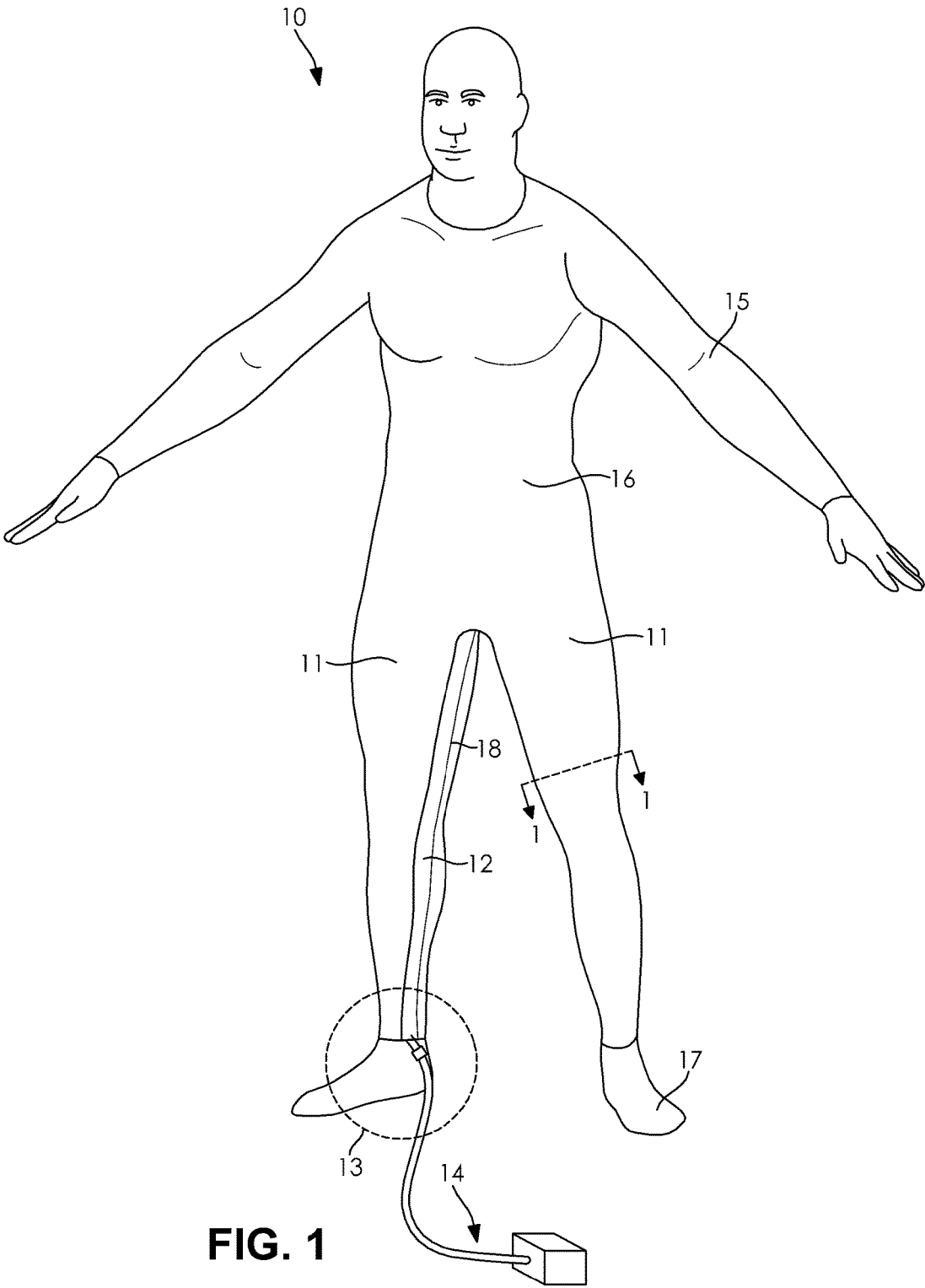


FIG. 1

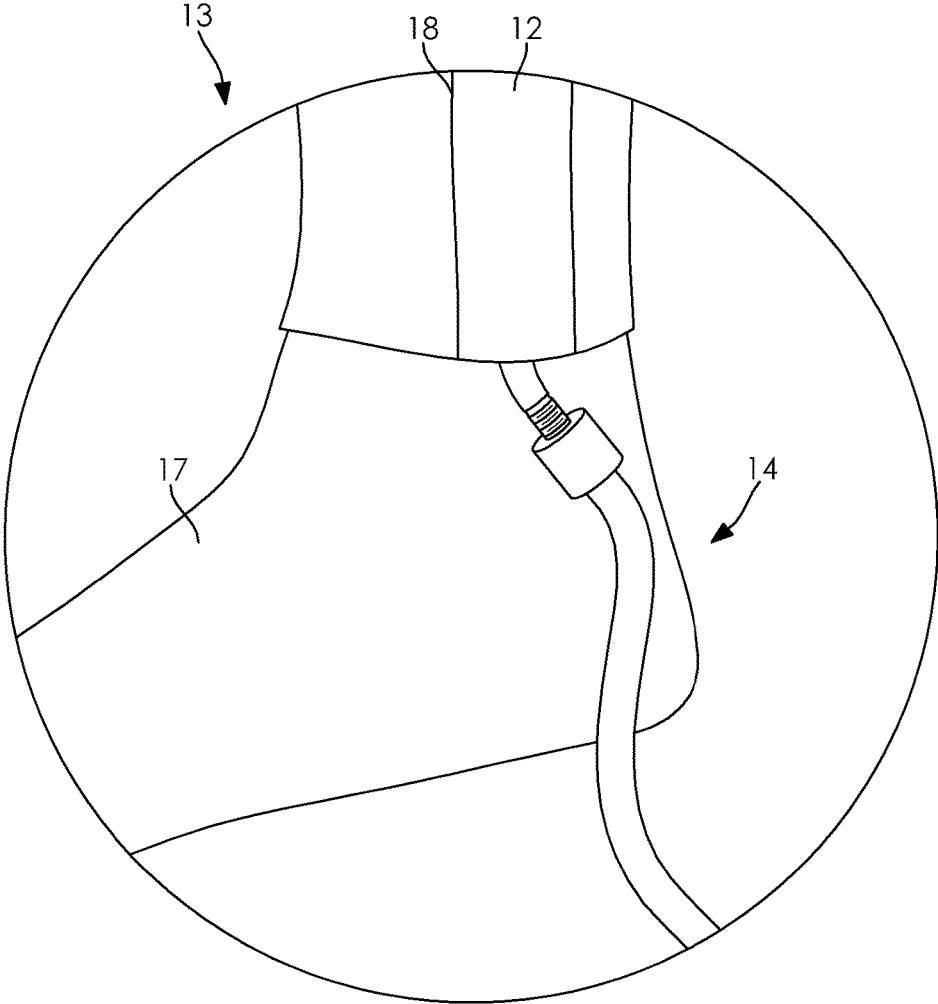


FIG. 2

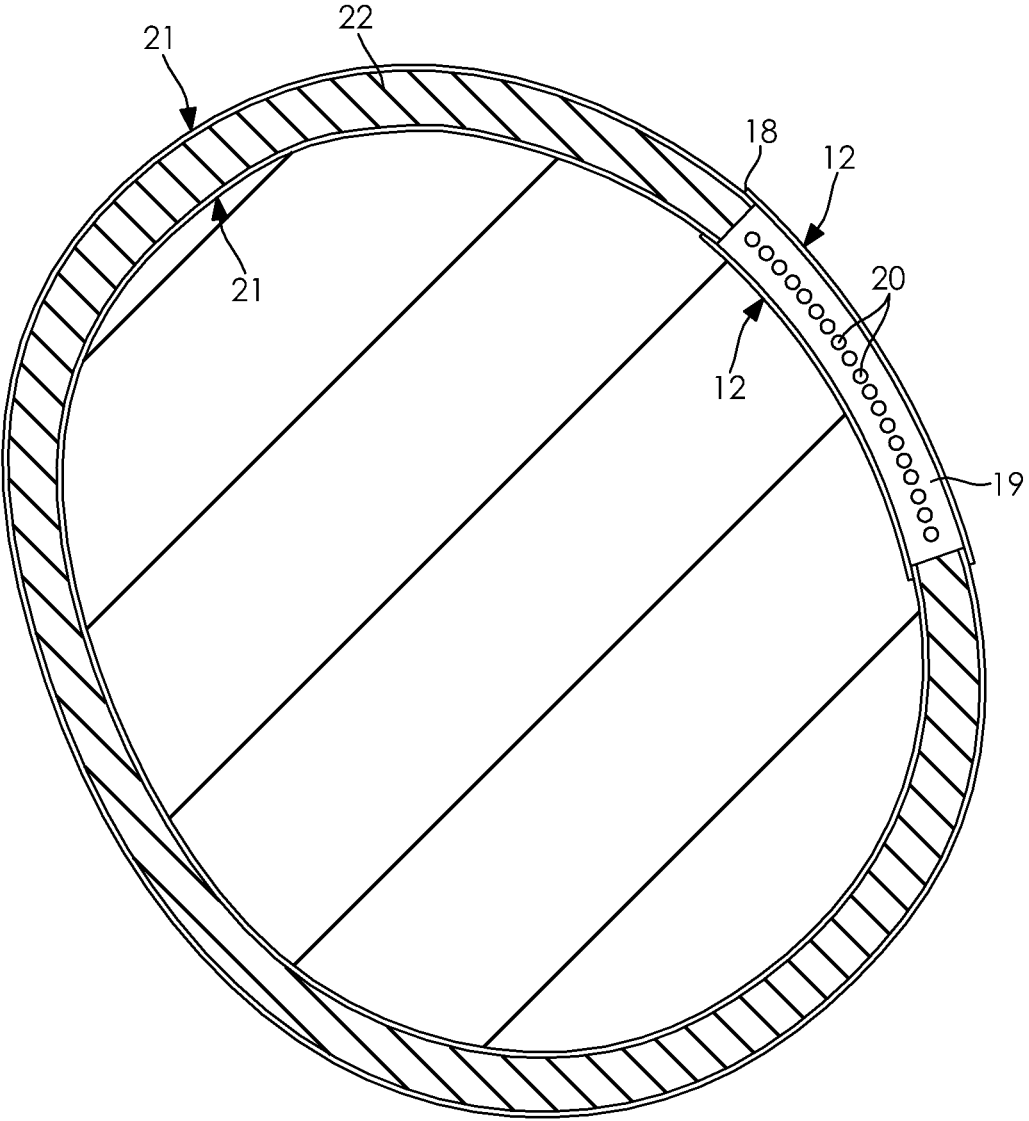


FIG. 3



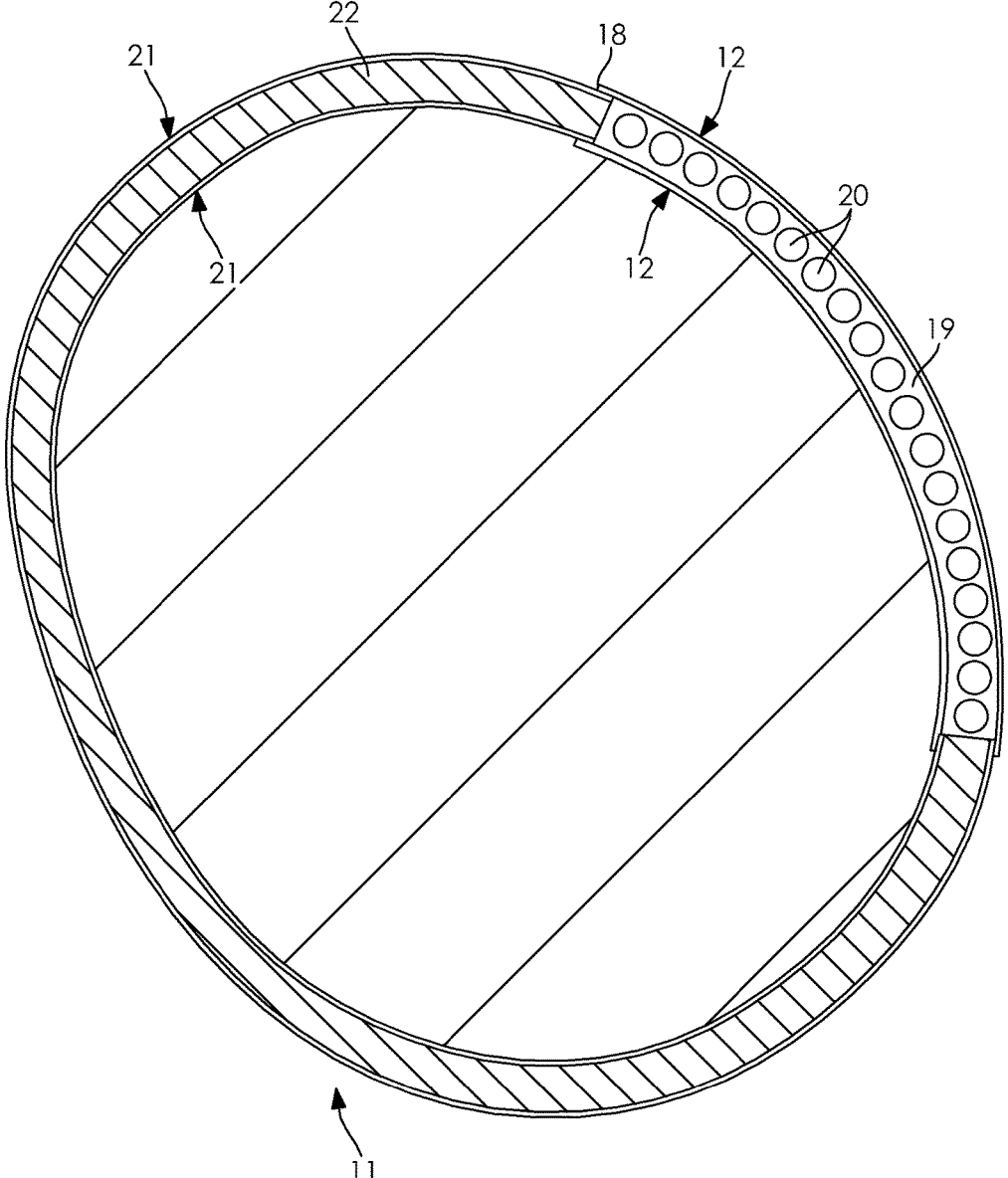
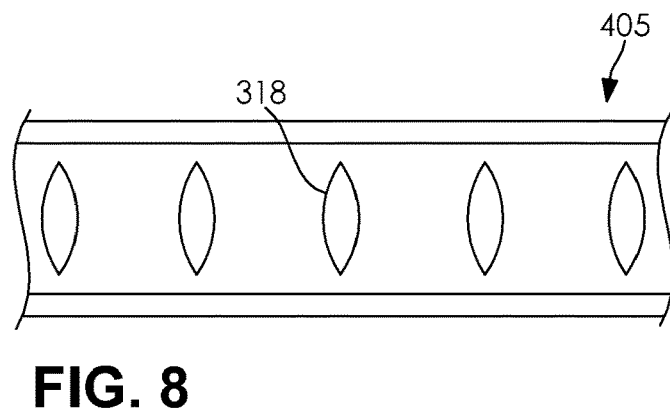
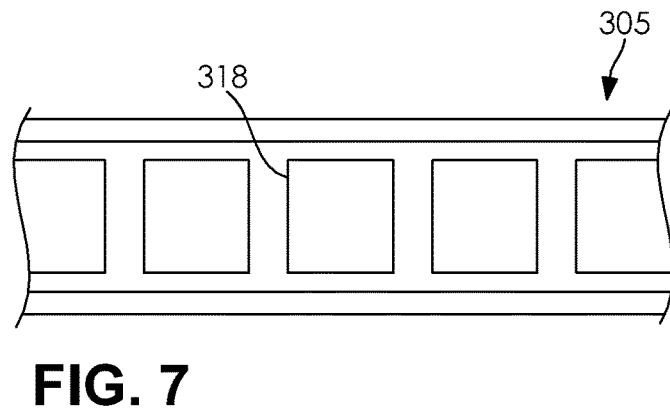
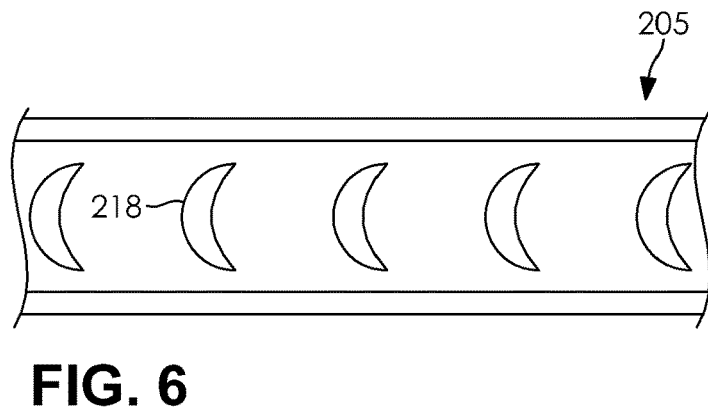
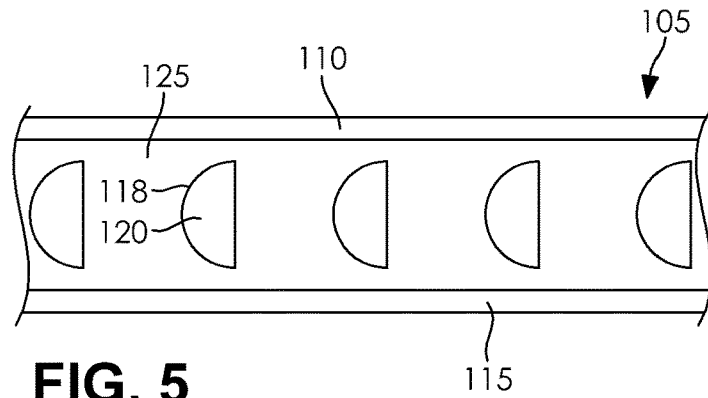
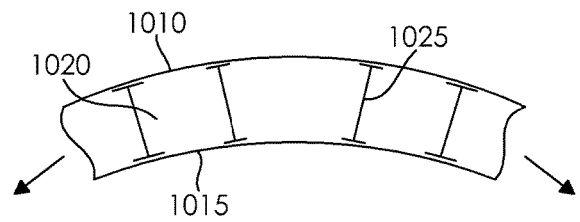
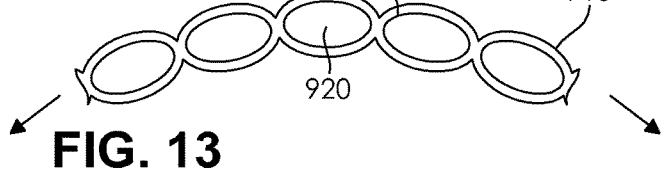
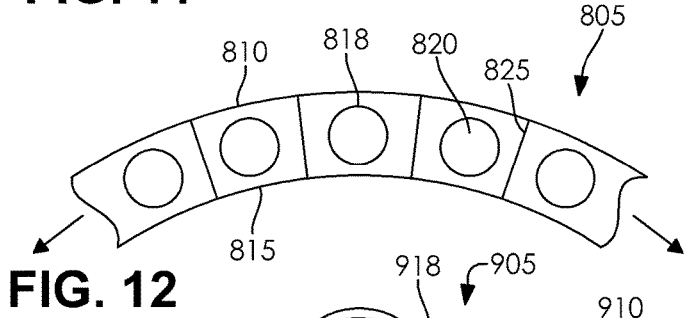
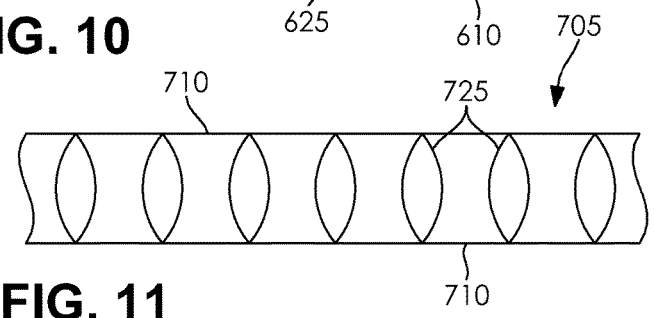
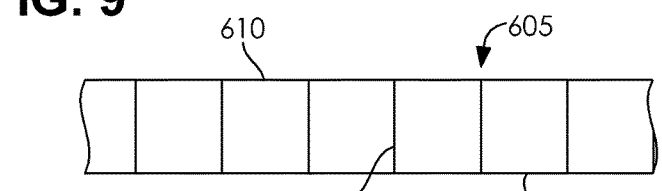
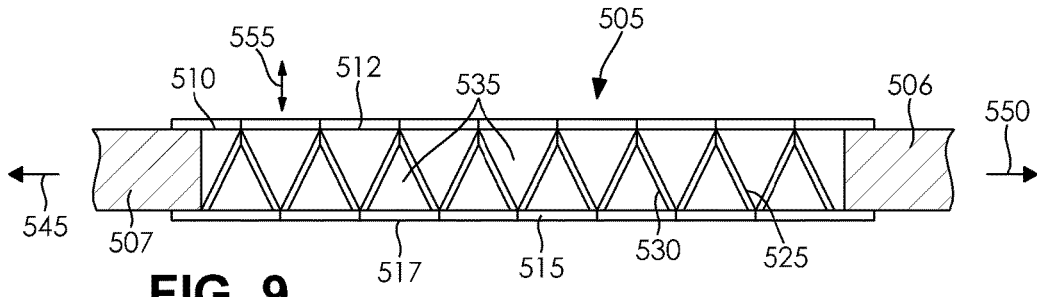


FIG. 4





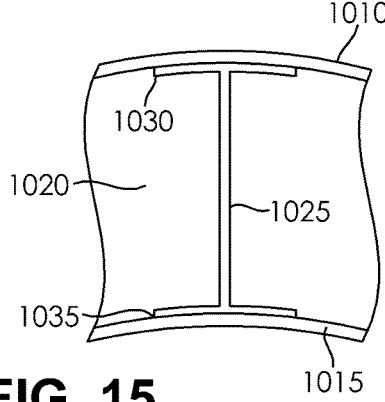


FIG. 15

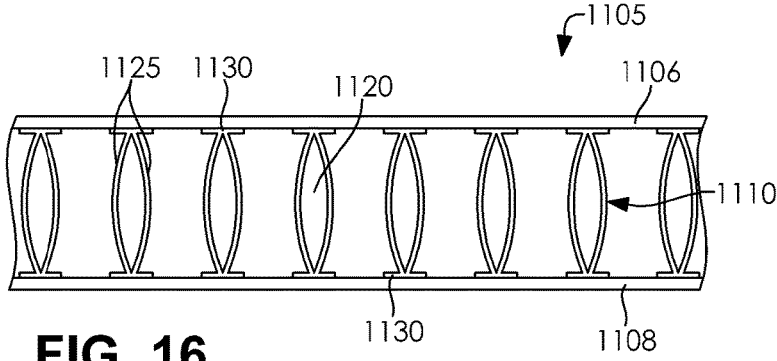


FIG. 16

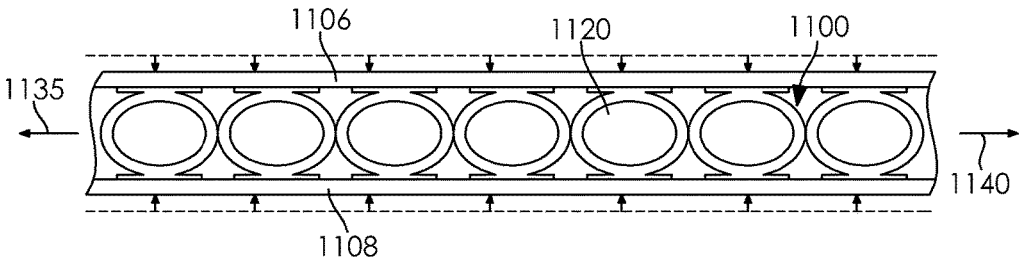


FIG. 17

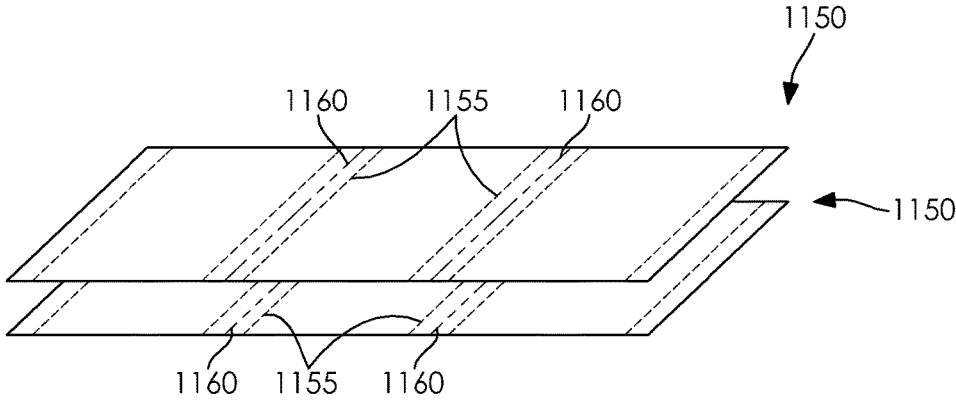


FIG. 18

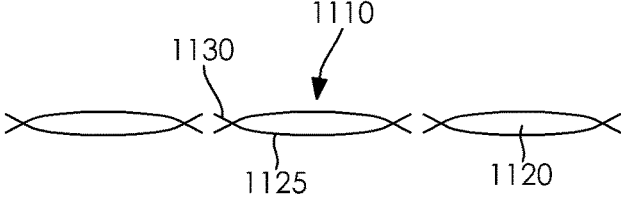


FIG. 19

MATERIAL HAVING AN EXPANDABLE PORTION

RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application Ser. No. 62/426,712, filed Nov. 28, 2016.

TECHNICAL FIELD

[0002] The present disclosure generally relates to materials for use in apparel and accessories such as fabrics and textiles. For example, embodiments of the present disclosure may be directed to material for use in clothing, apparel, shape wear, compression wear (e.g., medical compression devices), athletic support wear, utility wear (e.g., wetsuits, hazmat suits), accessories or other items where fit or usage of such apparel or accessories is generally tight or otherwise difficult to don in its ordinary state.

BACKGROUND

[0003] Many types of apparel, especially those with specific purposes, such as utility wear (e.g., wetsuits, medical compression wear) are form-fitting and provide advantageous results due to their tight and fitted nature. For instance, a tightly-fitting wetsuit minimizes the amount of water that can enter the wetsuit, thereby reducing the amount of water the body must heat. It prevents new cold water from circulating through the suit and instead retains a thin layer of water along the interior surface of the suit. This water is warmed by the body and is isolated from the outside cold water with an insulated barrier that keeps the majority of the colder water on the exterior of the suit. If a wetsuit is too loose, water is able to flow in and out of the wetsuit, significantly reducing its insulating ability. However, the form-fitting nature of the wetsuit (or other apparel types) can make donning the wetsuit difficult. Similar problems arise in other types of form-fitting apparel and accessories.

[0004] Also, some fabrics used in tight-fitting apparel and accessories in general may not be as elastic or flexible as other more common fabrics. The fact that such apparel and accessories are intended to be tightly or snugly fitting deems that they will be, in general, more difficult to don than looser fitting apparel or accessories (or less effective if made easier to don).

[0005] Thus, a need exists for fabrics or other materials for apparel and/or accessories that make such articles easier to put on and take off. These and other features and advantages of the present invention will be explained and will become obvious to one skilled in the art through the summary of the disclosure that follows.

SUMMARY OF THE DISCLOSURE

[0006] In one aspect, the present disclosure is directed to an article of apparel. The article of apparel includes a first portion that extends in a longitudinal direction of the article of apparel and a second portion that extends in the longitudinal direction. The second portion is attached to the first portion. The second portion is more expandable than the first portion. The second portion is expandable in both the longitudinal direction and in a transverse direction that is perpendicular to the longitudinal direction. The second portion is more expandable in the longitudinal direction in

which the first portion and the second portion extend than in the transverse direction that is perpendicular to the longitudinal direction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. 1 is a perspective view of apparel made from a material with an expandable portion, in accordance with an embodiment of the present invention;

[0008] FIG. 2 is a detail view of apparel made from a material with an expandable portion, in accordance with an embodiment of the present invention;

[0009] FIG. 3 is a sectional view (section 1-1 as shown in FIG. 1) of a material with an expandable portion, in accordance with an embodiment of the present invention;

[0010] FIG. 4 is a sectional view (section 1-1 as shown in FIG. 1) of a fabric with an expandable portion, in accordance with an embodiment of the present invention;

[0011] FIG. 5 is a schematic illustration of an exemplary expandable portion;

[0012] FIG. 6 is a schematic illustration of an exemplary expandable portion;

[0013] FIG. 7 is a schematic illustration of an exemplary expandable portion;

[0014] FIG. 8 is a schematic illustration of an exemplary expandable portion;

[0015] FIG. 9 is a schematic illustration of an exemplary expandable portion;

[0016] FIG. 10 is a schematic illustration of an exemplary expandable portion;

[0017] FIG. 11 is a schematic illustration of an exemplary expandable portion;

[0018] FIG. 12 is a schematic illustration of an exemplary expandable portion;

[0019] FIG. 13 is a schematic illustration of an exemplary expandable portion;

[0020] FIG. 14 is a schematic illustration of an exemplary expandable portion;

[0021] FIG. 15 depicts a detailed view of the exemplary expandable portion of FIG. 14;

[0022] FIG. 16 is a schematic illustration of an exemplary expandable portion in a first exemplary state;

[0023] FIG. 17 is a schematic illustration of the exemplary expandable portion of FIG. 16 in a second exemplary state;

[0024] FIG. 18 is a schematic illustration of an exemplary method for manufacturing the exemplary expandable portion of FIG. 16; and

[0025] FIG. 19 is another schematic illustration of an exemplary method for manufacturing the exemplary expandable portion of FIG. 16.

DETAILED DESCRIPTION AND INDUSTRIAL APPLICABILITY

[0026] The present disclosure generally relates to materials for use in apparel and accessories such as fabrics and textiles. Specifically, embodiments of the present invention may be directed to material such as fabric for use in clothing, apparel, shape wear, compression wear (e.g., medical compression devices), athletic support wear, utility wear (e.g., wetsuits, hazmat suits), accessories or other items where fit or usage of such apparel or accessories is generally tight or otherwise difficult to don in its ordinary state.

[0027] According to an exemplary embodiment of the present disclosure, a material is provided whereby a portion

of the material or apparel (e.g., fabric or textile) comprises at least one expandable portion (e.g., seam portion), wherein the expandable portion comprises one or more chambers (e.g., tubes) configured to expand when inflated. For example, inflating the tubes of the expandable portion of the fabric expands the fabric such that an article of clothing or an accessory made from such fabric becomes easier to don, due to the increase of open area on an inner surface of the clothing or accessory. It is also contemplated that while the deflated (and tight-fitting) mode of operation may be one possible configuration for an in-use state (e.g. wearing the article and utilizing it for its intended purposes as opposed to being in the act of donning) of an article, another potential mode of operation may be where an inflated (and loose-fitting) state is the regular in-use state (e.g., where perhaps only brief periods of reduction of pressure may be involved, which may be obtained by reducing the pressure of fluid in the tube).

[0028] According to an exemplary embodiment of the present disclosure, the expandable portions of the fabric can be integrated such that, when formed into an article of apparel or an accessory, the seams may be aligned on optimal portions of the article such that when expanded, the seams offer additional space in areas which would more traditionally be restricted. By creating additional space in these restricted areas, the articles become easier to don (e.g., without compromising function as the seams can be deflated after donned, which may return the article to its original form-fitting state).

[0029] Turning now to FIGS. 1-4, an exemplary embodiment of material such as an article of apparel, for example a wetsuit, formed from a fabric with expanding seams, in accordance with embodiments of the present disclosure, is shown. In this exemplary embodiment, an article of apparel (e.g., an article of clothing such as a wetsuit 10) comprises numerous regions which may be configured to be tightly laid over the skin of the wearer. These regions include, a torso region 16, an arm region 15, and a leg region 11. In these figures, an expanding seam 12 is depicted on leg region 11 of wetsuit 10. While these figures illustrate expanding seam 12 in leg region 11, one of ordinary skill in the art would appreciate that other regions, such as torso region 16 and arm region 15, could also include one or more expanding seam elements, even though not shown in FIGS. 1-4.

[0030] FIG. 2 illustrates a lower portion of leg region 11 (e.g., in the area shown by detail area 13), and illustrates in detail expanding seam 12. In this figure, expanding seam 12 may be integrated into the fabric of the material (e.g., wetsuit) along boundaries or lines 18. Inflation device 14 may include, for example, an air flow port that extends from a lower portion of expanding seam 12. In at least some exemplary embodiments of the present disclosure, an inflation device may be connected to an expanding seam of the fabric, in order to allow for the inflation and deflation of the expanding seam as desired. Inflation device 14 may include, for example, an air port, a fluidic connection valve, an inflation valve, a Schrader valve, a Presta valve, an American valve, or any combination thereof that may be connectable to a source of pressurized fluid, which may be attached to an inflation tube of the expanding seam (for example, components of inflation device 14 may be located in any suitable location, such as near a foot 17 of a user). For example, inflation device 14 may also include a source of pressurized fluid (e.g., a source of pressurized fluid such as

pressurized gaseous fluid such as a pressurized CO₂ or a pressurized air cartridge or a source of pressurized liquid fluid), a pump (e.g., an automated or manual pump that pressurizes gas or liquid fluids such as air), or any other suitable assembly for pressurizing a fluid (e.g., any suitable type of pump, motor, gravity-assisted device, thermal expansion device, hand compression bulb such as those found on blood pressure cuffs, or engine for pressurizing fluid). Further, while at least some embodiments utilize expanding seams that are expanded via the use of pushing air or other fluids (e.g., gaseous fluids) into the expandable portion, other embodiments could utilize other expanding elements, such as liquid fluids (e.g., water or other suitable liquids). One of ordinary skill in the art would appreciate that there are numerous types of inflation devices and expanding elements that could be utilized with embodiments of the present disclosure, and embodiments of the present disclosure may be contemplated for use with any appropriate inflation devices and expanding elements.

[0031] In the exemplary embodiment of FIG. 2, inflation device 14 could be used to allow for the insertion of fluid (e.g., gaseous fluid air or other type of gas, or a liquid fluid) into the expanding seam 12, such as from air being pushed via an air compressor or other source (e.g., air pump). One of ordinary skill in the art would appreciate that there are numerous sources that could push air or other fluids (e.g., gaseous fluids such as air or liquid fluids) through the inflation device 14 and into the expanding seam 12, and embodiments of the present invention are contemplated for use with any appropriate source.

[0032] FIGS. 3 and 4 illustrate an exemplary embodiment of a fabric with an expanding seam, in accordance with at least some exemplary embodiments of the present disclosure. FIG. 3 illustrates a sectional view 1-1 from FIG. 1. In these figures, a fabric 22 may be formed with inner and outer walls 21. Fabric 22 may connect to the expanding expandable portion (e.g., seam portion) at boundary or line 18. The expandable portion may comprise interior and exterior walls 12 and a plurality of housings 20 (any suitable housing including a partially or substantially fully empty chamber or cavity such as, for example, an inflatable tube). In at least some exemplary embodiments, inside the expandable portion there is also negative (e.g., substantially empty) space 19, which may be filled by the housings 20 when they are inflated. The housings 20 and the negative space 19 may work in conjunction to allow for the expansion and contraction of the expanding seam, such that an operable functionality is provided (e.g., the expandable portion expands based on an expansion of housings 20 and a corresponding elongation of interior and exterior walls 12) to the article of clothing or accessory formed from fabrics in accordance with embodiments detailed herein. In at least some exemplary embodiments, housings 20 may be formed from stretchable material, so that when housings 20 are inflated for example by inflation device 14, housings 20 expand in size under the increase in pressure within housings 20 provided by inflation device 14. For example, as housings 20 expand within empty space 19, the expansion causes interior and exterior walls 12 to elongate, which causes the expandable portion (e.g., expandable seam portion) to expand or elongate.

[0033] The expandable portion may include components of various shapes and configurations. For example, as illustrated in the below exemplary embodiments, the expandable

portion may include any suitable shape and/or configuration for providing expandable members for use with the exemplary disclosed article.

[0034] FIG. 5 illustrates an exemplary expandable portion 105. Expandable portion 105 may include member 110 and member 115 that may be stretchable or expandable members that may be formed from or include any suitable stretchable or expandable materials such as, for example, elastomeric material, natural rubber, spandex, synthetic rubber, neoprene, latex, chloroprene, vinyl material, nylon, thermoplastic elastomers, or any other suitable type of fabric, textile, or material having elastic properties. Expandable portion 105 may also include one or more members 118 that may be partially or substantially fully hollow members. Members 118 may be formed from stretchable or expandable material that is similar to the material of members 110 and 115. Each member 118 may include a chamber 120 that may be filled with fluids (e.g., gaseous or liquid fluids) such as, for example, air, nitrogen, O₂, CO₂, water, and/or any other gaseous or liquid fluid that is suitable to inflate a portion of expandable portion 105. For example, chamber 120 may be an air-tight cavity that may be filled with and/or hold pressurized fluid (e.g., pressurized gas or liquid). Members 118 may expand to a larger size when chamber 120 is filled with fluids such as, for example, via an operation of inflation device 14. A cavity 125 may be formed between members 110 and 115. Members 118 may be disposed within cavity 125. Cavity 125 may be a partially or substantially fully empty cavity (e.g., empty of solids and/or liquids). Members 118 may expand when filled with fluids (e.g., when chambers 120 are filled) and thereby take up additional space within cavity 125. As members 118 expand within cavity 125, members 118 may push adjacent members 118 away from each other so that an overall expansion or stretching of expandable portion 105 results. It is also contemplated that adjacent members 118 may come into contact with each other, providing additional force to cause expandable portion 105 to expand. As members 118 expand, members 110 and 115 may stretch, allowing for an expansion of expandable member 105.

[0035] For example, expandable portion 105 may include a plurality of intermediate (e.g., expandable) members 118 disposed in one or more cavities (e.g., see below embodiments) formed between members 110 and 115. At least one, some, or all of the plurality of intermediate (e.g., expandable) members 118 may include an air-tight cavity (e.g., chamber 120). For example, the plurality of intermediate expandable members 118 may be inflatable. Also for example, the plurality of intermediate expandable members 118 may inflate when holding a pressurized fluid (e.g., gaseous fluid and/or liquid fluid) provided by an operation of inflation device 14.

[0036] As shown in FIGS. 6-8, members of the exemplary expandable members may be disposed in any suitable configuration for providing expansion of the exemplary expandable members. For example, members of the exemplary expandable portions may have members such as, for example, members 218 (e.g., sickle or crescent shaped of an expandable portion 205), members 318 (e.g., square, rectangular, or diamond shaped of an expandable portion 305), and members 418 (e.g., elongated or oval shaped of an expandable portion 405), which may be similar to member 118. For example, any of the exemplary expandable mem-

bers disclosed herein may have any suitable combination of suitable shapes for providing expansion.

[0037] FIG. 9 illustrates an exemplary expandable portion 505. Expandable portion 505 may, for example, be attached to portions 506 and 507 of an article of apparel (e.g., clothing material). Portions 506 and 507 may be less expandable than expandable portion 505. For example, portions 506 and 507 may be formed from a material or fabric that has little or substantially no expandability or flexibility (e.g., textile fabrics such as cotton, polyester, and/or other suitable materials having little or no elasticity). Expandable portion 505 may be more expandable than portions 506 and 507. For example, expandable portion 505 may be at least twice as expandable than portions 506 and 507. For example, expandable portion 505 may be more expandable than portions 506 and 507 in a longitudinal direction (e.g., a longitudinal direction 545 and/or 550 as shown by the arrows shown in FIG. 9). It is also contemplated that portion 506 and/or portion 507 may be formed from a similar material as expandable portion 505.

[0038] Expandable portion 505 may include members 510, 512, 515, and 517 that may be stretchable members that may be formed from similar material as members 110 and 115. Expandable portion 505 may also include a plurality of members 525 and 530 that may be attached to the other elements of expandable portion 505 as shown in FIG. 9. Members 525 and 530 may be formed from any suitable material that is substantially non-stretchable (e.g., having little or no expandability or flexibility, e.g., having little or substantially no elasticity). For example, members 525 and 530 may be formed from non-stretchable materials such as, for example, plastic, metallic, composite, wood, or any other suitable non-stretchable material. The plurality of members disclosed above (e.g., members 510, 512, 515, 517, 525, and 530) may form a plurality of chambers 535 (e.g., cavities) that may be filled with gaseous or liquid fluids similar to chamber 120. When chambers 535 are filled with fluid (e.g., filled with air or carbon dioxide for example via an operation of inflation device 14), stretchable members 510, 512, 515, and 517 may expand (e.g., stretch) so that expandable portion 505 expands in a direction of the arrows shown in FIG. 9 (e.g., expand in longitudinal directions 545 and/or 550 of portions 505, 506, and 507). For example, members 525 and 530 may reduce expansion of expandable portion 505 in a transverse direction 555 that is substantially perpendicular to longitudinal directions 545 and 550. For example, expandable portion 505 may be more expandable in longitudinal directions 545 and/or 550 in which portions 505, 506, and 507 extend than in transverse direction 555 that is perpendicular to longitudinal directions 545 and 550. Similar exemplary relative expandability between longitudinal and transverse directions of the various members and components may be associated in other exemplary embodiments of the present disclosure as well.

[0039] Members and components shown in FIG. 9, as well as any or all of the embodiments disclosed herein, may be attached to each other to form the illustrated configurations according to any suitable techniques. For example, members and components may be attached via bonding (e.g., thermal or heat bonding), adhesion (e.g., glues and other adhesives), stitching, and/or any suitable attachment technique for use in articles of clothing material.

[0040] FIGS. 10 and 11 show additional exemplary embodiments that may be generally similar to expandable

portion **505** shown in FIG. 9, and thereby illustrate additional configurations that allow for an expansion of an exemplary expandable portion. For example, expandable portion **605** may include a plurality of stretchable members **610** and non-stretchable members **625** that may be similar, respectively to stretchable and non-stretchable members of expandable portion **505**. Similarly for example, expandable portion **705** may include a plurality of stretchable members **710** and non-stretchable members **725** that may be similar, respectively to stretchable and non-stretchable members of expandable portion **505**. Accordingly, as shown in FIGS. 9-11, any suitable configuration of members may be used to provide expansion of the exemplary expandable portions of the present disclosure.

[0041] FIG. 12 illustrates an exemplary expandable portion **805**. Expandable portion **805** may include members **810** and **815** that may be stretchable members that may be similar to members **110** and **115**. Expandable portion **805** may also include one or more members **818** that may be partially or substantially fully hollow stretchable members (e.g., having chambers **820**) that are similar to members **118**. Expandable portion **805** may also include a plurality of members **825** that may be non-stretchable members similar to members **525**. For example, members **825** may serve as ribs or baffling between members **810** and **815**. When chambers **820** are filled with fluid, stretchable members **810** and **815** may expand (e.g., stretch) so that expandable portion **805** expands in a direction of the arrows shown in FIG. 12. Simultaneously, non-stretchable members **825** may restrain expandable portion **805** from compressing in a direction that is perpendicular to the arrows shown in FIG. 12.

[0042] FIG. 13 illustrates an exemplary expandable portion **905**. Expandable portion **905** may include members **910** that may be formed from stretchable material that is similar to material of members **110** and **115**. A plurality of members **910** may be, for example, attached together (e.g., stitched together, quilted together, and/or fastened together by any suitable technique). Expandable portion **905** may also include one or more members **918** that may be partially or substantially fully hollow stretchable members (e.g., having chambers **920**) that are similar to members **118**. A plurality of members **918** may be disposed in members **910** in any suitable fashion, for example, as shown in FIG. 13. For example, expandable portion may accordingly comprise a chain of connected members **920** that are fastened together via attached members **910**. When chambers **920** are filled with fluid (e.g., pressurized fluid), stretchable members **920** may expand (e.g., stretch) so that expandable portion **905** expands in a direction of the arrows shown in FIG. 13.

[0043] FIG. 14 illustrates an exemplary expandable portion **1005**. Expandable portion **1005** may include members **1010** and **1015** that may be stretchable members that may be similar to members **110** and **115**. Expandable portion **1005** may also include a plurality of members **1025** that may be non-stretchable members formed from a material similar to member **525**. For example, members **1025** may serve as ribs or baffling between members **1010** and **1015**. As shown in FIG. 15, member **1025** may be attached to members **1010** and **1015** via bonds **1030** and **1035**. Bonds **1030** and **1035** may be air-tight attachments or bonds that provide an air-tight connection between members **1010**, **1015**, and **1025**. For example, based on a plurality of air-tight connections via the plurality of bonds **1030** and **1035** between

members **1010**, **1015**, and **1025**, a plurality of air-tight chambers **1020** may be formed. When chambers **1020** are filled with fluid (e.g., pressurized fluid), stretchable members **1010** and **1015** may expand (e.g., stretch) so that expandable portion **1005** expands in a direction of the arrows shown in FIG. 14. Simultaneously, non-stretchable members **1025** may restrain expandable portion **1005** from expanding in a direction that is perpendicular to the arrows shown in FIG. 14, while still providing air-tight connections to members **1010** and **1015** via the plurality of bonds **1030** and **1035**.

[0044] FIG. 16 illustrates an exemplary expandable portion **1105**. Similarly to the exemplary embodiment shown in FIG. 9, expandable portion **1105** may be attached to non-expandable portions that may be similar to portions **506** and **507** (e.g., expandable portion **1105** may be more expandable than nonexpandable portions similar to portions **506** and **507**, to which expandable portion **1105** may be attached). Expandable portion **1105** may include members **1106** and **1108** that may be stretchable members that may be similar to members **110** and **115**. Expandable portion **1105** may also include a plurality of members **1110** that may be disposed between members **1106** and **1108**. Member **1110** may be formed from a nonexpandable material. Member **1110** may, for example, be formed from a material that does not substantially expand or stretch out to increase in size, but does allow for a change or shift in shape (e.g., deformable). For example, member **1110** may be formed from a deformable material that allows for a change in shape (e.g., changing from an oval or elliptical shape of FIG. 16 to a round shape of FIG. 17). The change in shape depicted in FIG. 16 or 17 illustrates an exemplary embodiment of a change of shape of member **1110**. For example, member **1110** may be formed from a material that may change shape while maintaining a substantially same length or perimeter as shown in FIGS. 16 and 17. For example, nonexpandable members **1110** may be shape-changeable while maintaining a substantially constant perimeter length (e.g., as shown in the exemplary embodiment illustrated in FIGS. 16 and 17). For example, nonexpandable members **1110** may be shape-changeable when holding a pressurized fluid (e.g., when holding a pressurized gas or liquid provided by an operation of inflation device **14**). Member **1110** may additionally have any suitable shape and may change between any suitable shapes (e.g., such as the shapes shown in FIGS. 5-8). Member **1110** may for example be formed from plastic material, plastic-like material, composite material, or a hybrid material including polymeric, plastic, and/or any other suitable material for allowing a change of shape while substantially preventing a stretching or expansion of member **1110**. For example, member **1110** may be a thermoplastic-like PET material that may be formed as a sheet. Also for example, member **1110** may be formed from a thermoplastic or plastic resin (e.g., using a 3D printing or additive manufacturing process). Member **1110** may also be formed from any suitable material that is able to be made air-tight, whether based on the material's properties or its ability to accept coating or layers that may make member **1110** air-tight. For example, member **1110** may be able to bend and/or change shape while also being resistant to stretching. For example, member **1110** may be a preformed flat tube. Also for example, member **1110** may be formed as described further below relating to FIGS. 18 and 19.

[0045] For example, expandable portion **1105** may include a plurality of nonexpandable members **1110** disposed between a first expandable member (e.g., member **1106**) and a second expandable member (e.g., member **1108**). Each of the plurality of nonexpandable members **1110** may have a first end portion and second end portion. At least one first end portion may be attached to the first expandable member (e.g., member **1106**) and at least one second end portion may be attached to the second expandable member (e.g., member **1108**). Also for example, some or all first end portions of members **1110** may be attached to the first expandable member (e.g., member **1106**) and some or all second end portions of members **1110** may be attached to the second expandable member (e.g., member **1108**). Also for example, a plurality of nonexpandable members **1110** may be disposed substantially transversely to expandable members **1106** and **1108**.

[0046] Member **1110** may be partially or substantially fully hollow, and may have a chamber **1120**. Chamber **1120** may, for example, be a substantially air-tight cavity. Member **1110** may include intermediate portions **1125** and end portions **1130**. Chamber **1120** may be formed, for example, by (e.g., between) intermediate portions **1125**. End portions **1130** may be attached to members **1106** and **1108** as shown in FIGS. **16** and **17**. When chambers **1120** are filled with fluid (e.g., gaseous or liquid fluid via, for example, an operation of inflation device **14**), members **1110** may change shape while not substantially expanding or stretching (e.g., changing shape while not substantially increasing in length or perimeter). For example, when chambers **1120** are filled and/or hold pressurized fluid (e.g., such as air or another gaseous fluid, or a liquid fluid), members **1110** may change in shape from a shape shown in FIG. **16** to a shape shown in FIG. **17**. For example, members **1110** may change from an elliptical or oval shape to a substantially round shape when chambers **1120** hold fluid (e.g., pressurized fluid such as air, O₂, and/or CO₂). For example, as members **1110** change in shape from the exemplary shape of FIG. **16** to the exemplary shape of FIG. **17**, members **1106** and **1108** may be displaced as shown in FIG. **17**. For example, members **1106** and **1108** may be drawn toward each other based on a change in shape of members **1110**. Also, for example, expandable portion **1105** may expand (e.g., stretch) so that expandable portion **1105** expands in directions **1135** and **1140** shown in FIG. **17**. For example, (e.g., nonexpandable) members **1110** may be shape-changeable members that pull members **1106** and **1108** toward each other while stretching members **1106** and **1108** when nonexpandable members **1110** are filled with a pressurized fluid (e.g., pressurized gaseous fluid and/or pressurized liquid fluid). It is contemplated that member **1110** may include any suitable shapes for allowing an expansion of expandable portion **1105** such as, for example, the exemplary shapes illustrated in FIGS. **5-8**. It is also contemplated that member **1110** may also include a stretchable material similar to members **110** and **115**.

[0047] FIGS. **18** and **19** illustrate an exemplary method for manufacturing an expandable portion such as, for example, expandable portion **1105**. For example, substantially similar portions of material **1150** may be provided. Material **1150** may be formed from material similar to the material of member **1110** described above. For example, material **1150** may be sheets of material (e.g., elongated material, or substantially flat sheets of material). Similar portions of material **1150** may be provided parallel to each other as

shown, for example, in FIG. **18**. Material **1150** may include a plurality of lines **1155** and **1160**. For example, line **1155** may be a location for attaching material **1150**. For example, line **1155** may be a line along which sheets of material **1150** are attached by any suitable technique. For example, sheets of material **1150** may be attached via bonding, heat pressing, attaching using adhesive, or any other suitable technique for attaching material **1150**. Following attachment along lines **1155**, attached portions of material **1150** may be separated along lines **1160**. For example, attached sheets of material **1150** may be cut along lines **1160**. It is also contemplated that portions of material **1150** may be cut along lines **1160** prior to attachment at lines **1155**.

[0048] As shown in FIG. **19**, discrete members **1110** may be formed via the above exemplary manufacturing method. End portions **1130** shown in FIGS. **16**, **17**, and **19** may be formed between adjacent lines **1155** and **1160** shown in FIG. **18**. Intermediate portions **1125** shown in FIGS. **16**, **17**, and **19** may be formed between adjacent lines **1155** shown in FIG. **18**. For example, attachment (e.g., heat pressing and/or bonding) along lines **1155** may provide air-tight bonds between portions of material **1150**. Accordingly for example, chambers **1120** may be substantially air-tight cavities that may be filled with and/or hold unpressurized and/or pressurized fluids (e.g., air, O₂, and/or CO₂ or other suitable fluid gases or fluid liquids). It is also contemplated that additional exemplary methods may be used to manufacture the exemplary components disclosed herein such as 3D printing (e.g., dual material 3D printing), plastic extrusion techniques utilizing stretch components or sheets that are subsequently adhered, and/or cutting blocks of material to form housings and adhering stretch material to the housings (e.g., slicing a solid block of plastic to form hollow tubes, and then adhering stretch material to the solid tubes).

[0049] The exemplary disclosed article of material (e.g., article of apparel) having an expandable portion may be used in any application involving tight-fitting or form-fitting articles. For example, the exemplary disclosed expandable portion may be used with form-fitting articles such as form-fitted clothing and apparel, shape wear, compression wear (e.g., medical compression devices used on any body part), athletic support wear, and utility wear (e.g., wetsuits, hazmat suits) to maintain the benefits of such form-fitting articles while allowing the user of the articles to don and remove the articles in a relatively easy manner. It is also contemplated that the exemplary expandable portion may be used on any application involving form-fitting material such as, for example, appearance-improving applications such as corsets and similar clothing devices, braces for use in correcting posture or body position (e.g., braces such as back braces and knee braces), and/or specialized articles such as athletic devices (e.g., equipment for activities such as cross-fit equipment and weight-lifting belts). An operation of the article of exemplary-disclosed material clothing having one or more expandable portions is explained below.

[0050] A user may be provided with a form-fitting article of clothing such as form-fitted clothing and apparel, shape wear, compression wear (e.g., medical compression devices), athletic support wear, and utility wear (e.g., wetsuits, hazmat suits) to don for use in a given application. For example, a user may wish to don a wetsuit as shown in FIGS. **1** and **2**. Prior to donning for example an article of apparel or material **10** (e.g., as shown in FIGS. **1** and **2**), the user operates inflation device **14**. For example, prior to donning

article of material **10**, the user uses inflation device **14** to direct a fluid (e.g., a gaseous or liquid fluid) into the exemplary expandable portion (e.g., expandable portions **12**, **105**, **205**, **305**, **405**, **505**, **605**, **705**, **805**, **905**, **1005**, or **1105**). For example, the user may use an inflation device **14** (e.g., any of the exemplary embodiments of inflation device **14** disclosed above) to provide pressurized fluid (e.g., pressurized gaseous and/or liquid fluids) to the exemplary disclosed chambers (e.g., housings **20**, chambers **120**, cavities of members **218**, **318**, or **418**, and/or chambers **535**, cavities of expandable portion **605** and **705**, chambers **820**, **920**, **1020**, and **1120**).

[0051] Once the above exemplary disclosed chambers and cavities are filled with and/or are holding fluid (e.g., pressurized gaseous and/or liquid fluids), the various exemplary disclosed fluid-holding members expand and/or change shape. For example, housings **20**, members **118**, **218**, **318**, and/or **418**, chamber **535**, cavities of expandable portion **605**, members **725**, **818**, and **918**, and/or chamber **1020** will expand in size. For example, based on this expansion, seam **12** and/or members **110**, **115**, **510**, **512**, **515**, **517**, **610**, **710**, **810**, **815**, **910**, **1010**, and/or **1015** will stretch so that expandable portions **12**, **105**, **205**, **305**, **405**, **505**, **605**, **705**, **805**, **905**, and/or **1005** will expand. Such expansion will make donning an article of material or apparel relatively easy for a user. Once the article of material is donned, the user disconnects a pressurized air source or pump portion of inflation device **14**. Pressurized fluid then escapes from the exemplary expandable portions and a stretching of the above members is reversed so that the members return to their previous (e.g., unstretched) configurations.

[0052] When the user is finished using the article of material and wishes to remove the article, the user again operates inflation device **14** to cause the exemplary-disclosed expandable portions to stretch as described above. Once the expandable portions are expanded, the user can take off the article of material **10** in a relatively easy manner. Once the article has been removed, the user deactivates and/or disconnects inflation device **14** so that the expandable portions unstretch back (e.g., revert back to or recoil) to their previous position.

[0053] An operation of expandable portion **1105** is similar to the operation described above, except that the members **1110** may not substantially stretch or expand. Instead, when chambers **1120** are filled with and/or hold fluid (e.g., pressurized gaseous or liquid fluid), members **1110** change shape (for example as shown in FIGS. **16** and **17**) such that expandable portion **1105** stretches or expands.

[0054] The above disclosed exemplary articles of clothing material having expandable portions may provide form-fitting articles of clothing that provide benefits of tight-fitting clothing material (e.g., utility wear) while still allowing such articles to be relatively easily donned. For example, the exemplary disclosed expandable portions may allow for form-fitting articles such as form-fitted clothing and apparel, shape wear, compression wear (e.g., medical compression devices), athletic support wear, and utility wear (e.g., wetsuits, hazmat suits) to maintain the various benefits associated with form-fitted articles of material while still allowing users to don and remove the articles of clothing in a relatively easy manner based on an operation of the exemplary disclosed expandable portions. The exemplary disclosed expandable portions may also allow a user to avoid applying excess force while donning and removing a form-

fitting article that could result in deformation or subsequent improper operation of a form-fitting article.

[0055] It should be noted that the features illustrated in the drawings are not necessarily drawn to scale, and features of one embodiment may be employed with other embodiments, as the skilled artisan would recognize, even if not explicitly stated herein. Descriptions of well-known components and processing techniques may be omitted so as to not unnecessarily obscure the embodiments.

[0056] It will be apparent to those skilled in the art that various modifications and variations can be made to the disclosed article of material and method. Other embodiments will be apparent to those skilled in the art from consideration of the specification and practice of the disclosed method and apparatus. It is intended that the specification and examples be considered as exemplary only, with a true scope being indicated by the following claims and their equivalents.

What is claimed is:

1. An article of apparel, comprising:

a first portion that extends in a longitudinal direction of the article of apparel; and

a second portion that extends in the longitudinal direction, the second portion being attached to the first portion; wherein the second portion is more expandable than the first portion;

wherein the second portion is expandable in both the longitudinal direction and in a transverse direction that is perpendicular to the longitudinal direction; and wherein the second portion is more expandable in the longitudinal direction in which the first portion and the second portion extend than in the transverse direction that is perpendicular to the longitudinal direction.

2. The article of apparel of claim 1, wherein the second portion is at least twice as expandable in the longitudinal direction than in the transverse direction.

3. The article of apparel of claim 1, wherein a plurality of expandable members is disposed in the second portion.

4. The article of apparel of claim 3, wherein the plurality of expandable members inflates when holding a pressurized fluid.

5. The article of apparel of claim 3, wherein the plurality of expandable members inflates when holding pressurized air, O₂, or CO₂.

6. The article of apparel of claim 4, wherein the pressurized fluid is provided by an operation of an inflation device.

7. The article of apparel of claim 1, wherein the article of apparel is a wetsuit.

8. An article of apparel, comprising:

a first portion; and

a second portion that is attached to the first portion; wherein the second portion is more expandable than the first portion;

wherein the second portion includes a first expandable member and a second expandable member;

wherein the second portion includes a plurality of non-expandable members disposed between the first expandable member and the second expandable member, each of the plurality of nonexpandable members having a first end portion and second end portion;

wherein at least one first end portion is attached to the first expandable member; and

wherein at least one second end portion is attached to the second expandable member.

9. The article of apparel of claim 8, wherein the nonexpandable members are shape-changeable while maintaining a substantially constant perimeter length.

10. The article of apparel of claim 8, wherein the nonexpandable members are shape-changeable when holding a pressurized fluid.

11. The article of apparel of claim 8, wherein the nonexpandable members are shape-changeable when holding a pressurized fluid provided by an operation of an inflation device.

12. The article of apparel of claim 8, wherein the nonexpandable members are shape-changeable members that pull the first and second expandable members toward each other while stretching the expandable members when the nonexpandable members are filled with a pressurized fluid.

13. The article of apparel of claim 8, wherein all first end portions are attached to the first expandable member and all second end portions are attached to the second expandable member.

14. The article of apparel of claim 3, wherein the nonexpandable members are disposed substantially transversely to the first and second expandable members.

15. An article of apparel, comprising:

a first portion; and

a second portion that is attached to the first portion;

wherein the second portion is more expandable than the first portion;

wherein the second portion includes a first expandable member and a second expandable member;

wherein the second portion includes a plurality of intermediate expandable members disposed in one or more cavities formed between the first expandable member and the second expandable member; and

wherein at least one of the plurality of intermediate expandable members includes an air-tight chamber.

16. The article of apparel of claim 15, further comprising a plurality of nonexpandable members disposed between the first and second expandable members.

17. The article of apparel of claim 16, wherein:

each of the plurality of nonexpandable members has a first end portion and second end portion;

at least one first end portion is attached to the first expandable member; and

at least one second end portion is attached to the second expandable member.

18. The article of apparel of claim 15, wherein each of the plurality of intermediate expandable members includes an air-tight chamber.

19. The article of apparel of claim 15, wherein the intermediate expandable members are inflatable.

20. The article of apparel of claim 15, wherein the intermediate expandable members inflate when holding a pressurized fluid provided by an operation of an inflation device.

* * * * *