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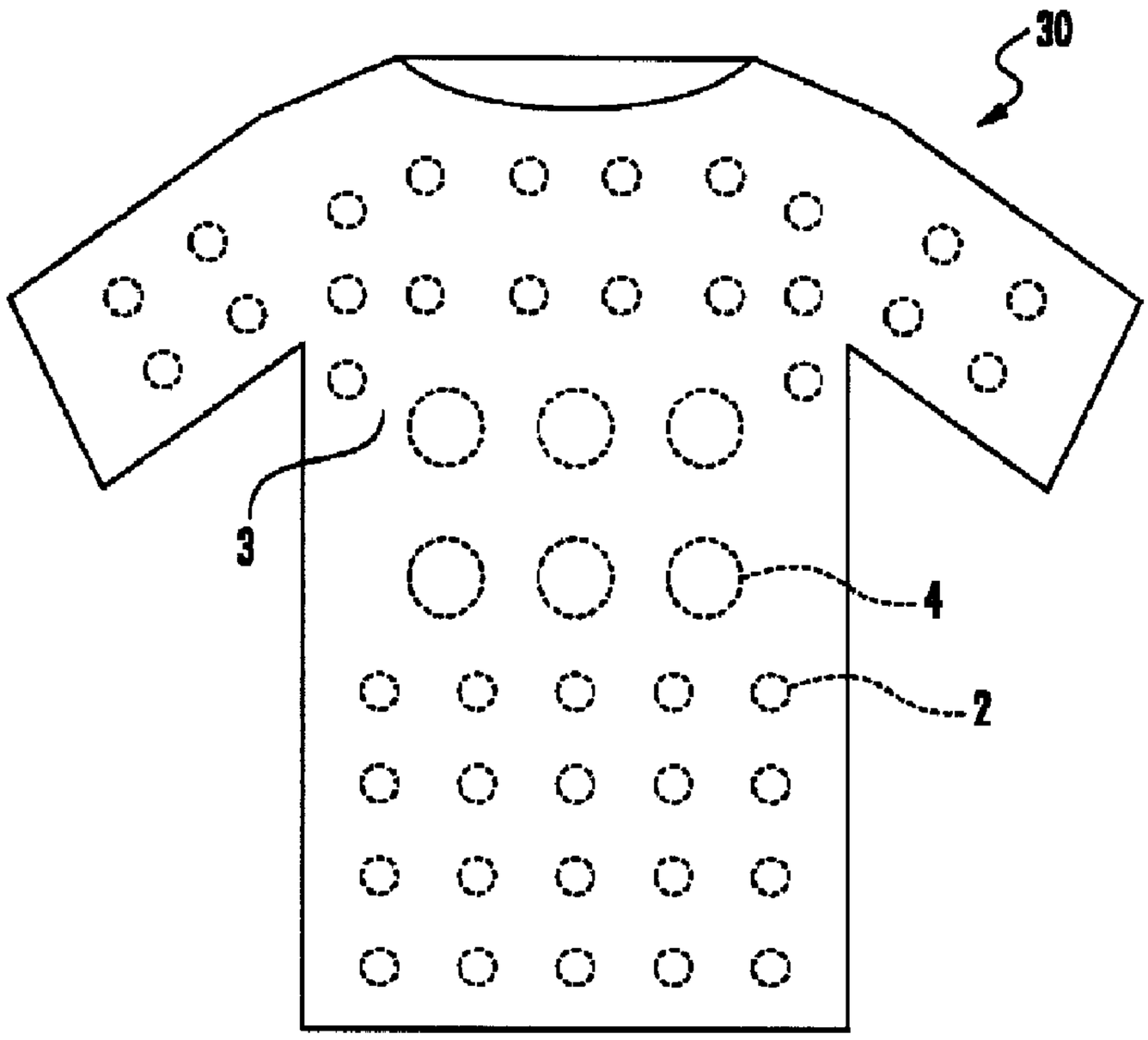
(54) **Titre : SILHOUETTE SANS COUTURE DOTEE DE PROPRIETE D'ISOLEMENT FABRIQUEE**
(54) **Title: SEAMLESS SILHOUETTE WITH ENGINEERED INSULATION PROPERTY**



(57) **Abrégé/Abstract:**
Certain embodiments according to the invention provide seamless insulation articles suitable for a wide variety of uses (e.g., garments, footwear, home textile articles, etc.). In accordance with certain embodiments, the seamless insulation article includes a

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(57) **Abrégé(suite)/Abstract(continued):**
knit base comprising a first yarn and a second yarn incorporated into a continuous web defined by the first yarn and the second yarn in a predetermined pattern to form a plurality of three-dimensional surfaces. The plurality of three-dimensional surfaces define at least two discrete regions having different contrasting insulative capacities arranged in the predetermined pattern, in which the at least two discrete regions comprise a first discrete region and a second discrete region. The first discrete region comprises a first insulative capacity, the second discrete region comprises a second insulative capacity, and the second insulative capacity is greater than the first insulative capacity.

ABSTRACT OF THE DISCLOSURE

Certain embodiments according to the invention provide seamless insulation articles suitable for a wide variety of uses (e.g., garments, footwear, home textile articles, etc.). In accordance with certain embodiments, the seamless insulation article includes a knit base comprising a first yarn and a second yarn incorporated into a continuous web defined by the first yarn and the second yarn in a predetermined pattern to form a plurality of three-dimensional surfaces. The plurality of three-dimensional surfaces define at least two discrete regions having different contrasting insulative capacities arranged in the predetermined pattern, in which the at least two discrete regions comprise a first discrete region and a second discrete region. The first discrete region comprises a first insulative capacity, the second discrete region comprises a second insulative capacity, and the second insulative capacity is greater than the first insulative capacity.

SEAMLESS SILHOUETTE WITH ENGINEERED INSULATION PROPERTY

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 62/071,162 filed on September 17, 2014, the entire contents of which are hereby incorporated herein by reference.

TECHNICAL FIELD

[0002] The presently-disclosed invention relates generally to insulation fabrics and more particularly to seamless insulation articles made with such insulation fabrics to provide insulation and moisture wicking while preventing chafing.

BACKGROUND

[0003] Thermally insulating textiles are commonly developed by containing air between the textile material and the skin and/or body of a user. To better contain air between the textile material and a user's skin, the bulk and/or thickness of the textile material is often increased, as thermal insulation of the textile material is directly correlated with the bulk or thickness of the material. To increase the bulk in a textile material, the textile material may undergo raising and/or napping to generate three-dimensional fleece. The thermal insulation of the textile material is directly related to the total bulk of the three-dimensional fleece surface because the higher bulk three-dimensional surfaces entrap more air than lower bulk three-dimensional surfaces or textile articles without three-dimensional surfaces. Although fleece increases a textile material's thermal insulation, it reduces the material's water management. As such, sweat remains on the skin for a long period of time, thereby creating an uncomfortable clammy feeling for the user.

[0004] To avoid the discomfort caused by fleece against the skin but still reap the benefits of fleece's thermal insulative properties, users frequently layer garments with a smooth base layer and an insulated (often fleece) mid layer. However, layering garments adds bulk and may impair a wearer's range of motion. Additionally, because different body areas have different temperature sensitivities and thermoregulative abilities, layering garments makes it difficult to provide appropriate insulation levels for all areas of the wearer's body.

[0005] Some fabric articles have attempted to offer regions having different heat and/or vapor exchange rates in one garment, but these fabric articles typically have numerous seams for joining together multiple areas and/or layers in the garment. As a result, these fabric articles have high production costs and waste associated with cutting, piecework, and sewing. Moreover, seams are often prone to failure. In addition, seams can be uncomfortable and may even chafe a wearer's skin.

[0006] Therefore there at least remains a need in the art for seamless insulation articles that provide insulation, breathability, and moisture management while preventing chafing.

BRIEF SUMMARY

[0007] One or more embodiments of the invention may address one or more of the aforementioned problems. Certain embodiments according to the invention provide seamless insulation articles suitable for a wide variety of uses (e.g., garments, footwear, home textile articles, etc.). In accordance with certain embodiments, the seamless insulation article includes a knit base comprising a first yarn and a second yarn incorporated into a continuous web defined by the first yarn and the second yarn in a predetermined pattern to form a plurality of three-dimensional surfaces. The plurality of three-dimensional surfaces, according to certain embodiments, may define at least two discrete regions having different contrasting insulative capacities arranged in the predetermined pattern such that the at least two discrete regions may comprise a first discrete region and a second discrete region. The first discrete region may comprise a first insulative capacity, the second discrete region may comprise a second insulative capacity, and the second insulative capacity may be greater than the first insulative capacity.

[0008] In another aspect, certain embodiments according to the invention provide methods for making seamless insulation articles. In accordance with certain embodiments, the method includes combining a first yarn and a second yarn in a continuous web in a predetermined pattern and finishing at least one surface of the continuous web to form a plurality of three-dimensional surfaces. The plurality of three-dimensional surfaces, according to certain embodiments, may define at least two discrete regions having different contrasting insulative capacities arranged in the predetermined pattern such that the at least two discrete regions may comprise a first discrete region and a second discrete region. The first discrete region may comprise a first insulative

capacity, the second discrete region may comprise a second insulative capacity, and the second insulative capacity may be greater than the first insulative capacity.

BRIEF DESCRIPTION OF THE DRAWING(S)

[0009] The invention now will be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all embodiments of the invention are shown. Indeed, this invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. Like numbers refer to like elements throughout.

[0010] Figure 1 illustrates a side view of a seamless insulated article according to an example embodiment.

[0011] Figure 2 illustrates a top view of a seamless insulated article of the example embodiment illustrated in Figure 1.

[0012] Figure 3 illustrates a side view of a seamless insulated article of the example embodiment illustrated in Figures 1-2 in use according to an example embodiment.

[0013] Figure 4 illustrates a side view of a seamless insulated article according to an example embodiment.

[0014] Figure 5 illustrates a top view of a seamless insulated article of the example embodiment illustrated in Figure 4.

[0015] Figures 6A-6G illustrate various seamless insulation articles in accordance with example embodiments.

[0016] Figure 7 illustrates a process flow diagram for making a seamless insulation article including the optional steps of designing the predetermined pattern, laminating the seamless insulated article with a second article, and removing the seamless insulated article from the continuous web according to the predetermined pattern according to an example embodiment.

DETAILED DESCRIPTION

[0017] The invention now will be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all embodiments of the invention are shown.

Indeed, this invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. As used in the specification, and in the appended claims, the singular forms "a", "an", "the", include plural referents unless the context clearly dictates otherwise.

[0018] In accordance with certain embodiments, the invention includes seamless insulation articles suitable for a wide variety of uses (e.g., garments, footwear, home textile articles, etc.). Seamless insulation articles, according to certain embodiments, may include a knit base comprising a first yarn. Such embodiments may also include a second yarn incorporated into a continuous web defined by the first yarn and the second yarn in a predetermined pattern to form a plurality of three-dimensional surfaces. In accordance with certain embodiments, the plurality of three-dimensional surfaces may define at least two discrete regions having different contrasting insulative capacities arranged in the predetermined pattern such that the at least two discrete regions may comprise a first discrete region and a second discrete region. The first discrete region may comprise a first insulative capacity, the second discrete region may comprise a second insulative capacity, and the second insulative capacity may be greater than the first insulative capacity. In this regard, the seamless insulation article may provide, for example, a base layer that incorporates the insulative properties of a fleece layer (e.g., a mid-fleece layer) into the base layer while maintaining the moisture wicking properties of a base layer and preventing chafing. In this regard, certain embodiments provide a single layer material (e.g., a seamless insulation article) that may provide or comprise the same or similar physical properties traditionally only realized by the use of multiple layers (e.g., a base layer in combination with a fleece layer).

[0019] In one aspect, the invention includes seamless insulation articles suitable for a wide variety of uses (e.g., garments, footwear, home textile articles, etc.) that provide insulation, breathability, and moisture management while preventing chafing. As used herein, the term "seamless" may comprise an article formed with no or in some embodiments a minimal number of sewn seams. In accordance with certain embodiments, the articles are devoid of any sewn seams. Figure 1 illustrates a side view of a seamless insulated article according to an example embodiment. In accordance with certain embodiments, the seamless insulation article 10 includes a knit base 1 comprising a first yarn and a second yarn incorporated into a continuous

web defined by the first yarn and the second yarn in a predetermined pattern to form a plurality of three-dimensional surfaces 2. In accordance with certain embodiments and as discussed in more detail below, the plurality of three-dimensional surfaces may be formed by utilizing the second yarn as a floating yarn, in which the second yarn is not anchored or strongly anchored into the continuous web at all areas of the continuous web. In this regard, the floating yarn (e.g., the second yarn) may be free or have a degree of freedom to generate the plurality of three-dimensional surfaces in the z-direction. The predetermined pattern may comprise three-dimensional surfaces of various predetermined sizes, spacings, and heights (*i.e.*, in the Z-direction perpendicular to the knit base). Figure 2 illustrates a top view of a seamless insulated article of the example embodiment illustrated in Figure 1. As shown in Figures 1 and 2, for example, the plurality of three-dimensional surfaces 2 may define at least two discrete regions 3, 6 having different contrasting insulative capacities arranged in the predetermined pattern such that the at least two discrete regions may comprise a first discrete region 6 and a second discrete region 3. For example, the first discrete region 6 may comprise a first insulative capacity, the second discrete region 3 may comprise a second insulative capacity, and the second insulative capacity may be greater than the first insulative capacity.

[0020] In accordance with certain embodiments and as illustrated by Figure 3, for instance, the seamless insulation article 10 may comprise an outer surface 7 and a skin surface 8. In such embodiments, for example, the outer surface 7 may comprise a smooth topography and may be positioned away from the body of a wearer. In this regard, the outer surface 7 may be exposed to the ambient environment or a second article (e.g., one or more layers of material, which may provide additional insulation, moisture management, water resistance, water repellency, etc.). Moreover, the plurality of three-dimensional surfaces 2 may be disposed on the skin surface 8 facing a wearer's skin 5 and may define a three-dimensional topography. However, in other embodiments, for instance, the skin surface 8 may comprise a smooth topography, and the outer surface 7 may comprise a three-dimensional topography such that the plurality of three-dimensional surfaces face the ambient environment rather than the skin 5. In certain embodiments, the skin surface, whether it has a smooth or three-dimensional topography, may be brushed, sanded, or generally softened to enhance the comfort level by imparting a softer touch to a wearer's skin and to reduce chaffing. In addition, the first yarn and/or the second yarn may comprise filaments and/or fiber bundles that improve the moisture wicking properties of the

seamless insulation article 10. In this regard, for example, the fiber bundles and/or filaments of the second yarn may contact a wearer's skin 5 via the plurality of three-dimensional surfaces 2 and thereby wick and transfer moisture from the skin 5 along the fiber bundles and/or filaments towards the outer surface 7. In some embodiments, for instance, the first yarn may comprise a first yarn denier, the second yarn may comprise a second yarn denier, and the first yarn denier may be finer than the second yarn denier such that the finer yarn faces away from the skin. In this regard, the differences in denier may enhance the movement of moisture (e.g., liquid sweat) from the skin to the outer surface 7, from where it will evaporate. In this regard, certain embodiments may comprise a greater amount of finer denier yarn on the surface of the article configured to be positioned away from a wearer. As such, the moisture wicking may reduce any discomfort to the wearer caused by a clammy feeling and/or a post-exercise chilling effect as a result of moisture retention. In this regard, for instance, certain embodiments beneficially provide targeted insulative capacity (e.g., localized regions of increased or decreased degrees of insulation based on the predetermined design) while simultaneously providing moisture management due, for example, by the transportation of moisture (e.g., sweat from a wearer) away from the skin of a wearer.

[0021] Furthermore, on the skin surface 8, according to certain embodiments, for example, the plurality of three-dimensional surfaces 2 may define a plurality of air channels 9 therebetween. In certain embodiments, for instance, the plurality of air channels 9 may extend in one direction (e.g., X or Y direction), both directions (e.g., X and Y directions), or intersect each other. In this regard, the plurality of air channels 9 may provide good thermal insulation in static conditions when no wind and/or no to low movement of the wearer (e.g., when the wearer is in a low metabolic state) and improved air movement through the plurality of air channels 9 and therefore better cooling, sweat evaporation, and less heat stress when the wearer is in an active state. As such, the plurality of air channels 9 may further improve the moisture transportation properties (e.g., evaporative cooling) of the seamless insulation article 10. For instance, the air channels may provide the article a structure in which the movement of air through the air channels facilitates or promotes transportation of moisture (e.g., sweat from a wearer) away from the skin of a wearer by, for example, moisture concentration gradients created or present between the wet or moist skin surface and the relatively less moist air travelling through the air channels. Such a transfer of moisture away from the skin of a wearer may not only reduce any clammy

feeling realized by the wearer due to unwanted sweat retention, but may also provide the additional benefit of providing a cooling effect to the wearer (e.g., evaporative cooling). Accordingly, certain embodiments may provide a desirable combination of localized or targeted insulative capacities; moisture management (e.g., moisture transportation away from the skin of a wearer by wicking and/or mass transport driven movement of moisture); and a cooling effect (e.g., evaporative cooling).

[0022] As noted above, certain embodiments may comprise a plurality of three-dimensional surfaces formed by utilizing the second yarn as, for example, a floating yarn, in which the second yarn is not anchored or strongly anchored into the continuous web at all areas of the continuous web. For instance, the floating yarn (e.g., the second yarn) may be free or loosely stitched into the continuous web at regions of location associated with the three-dimensional surfaces while the floating yarn (e.g., the second yarn) may be anchored to the continuous web and/or first yarn at regions associated, for example, with the air channels 9 illustrated in Figure 3. In this regard, the floating yarn (e.g., the second yarn) may generally free to move relative to the first yarn (e.g., to generate the plurality of three-dimensional surfaces in the z-direction) at regions associated with the three-dimensional surfaces while being secured to the first yarn at regions associated with the air channels.

[0023] According to certain embodiments, for instance, the plurality of three-dimensional surfaces may comprise at least a first group of three-dimensional surfaces 2 and a second group of three-dimensional surfaces 4. In such embodiments and as shown in Figures 4 and 5, for example, the first discrete region 6 of the seamless insulation article 20 may comprise the first group of three-dimensional surfaces 2, and the second discrete region 3 may comprise the second group of three-dimensional surfaces 4. However, in certain embodiments, for instance, the first discrete region 6 may not contain any three-dimensional surfaces. In some embodiments, for instance, the second group of three-dimensional surfaces may comprise a height from about 1 mm to about 20 mm. In other embodiments, for example, the second group of three-dimensional surfaces may comprise a height from about 1 mm to about 10 mm. In further embodiments, for instance, the second group of three-dimensional surfaces may comprise a height from about 3 mm to about 7 mm. As such, in certain embodiments, the second group of three-dimensional surfaces may comprise a height from at least about any of the following: 1, 1.5, 2, 2.5, and 3 mm and/or at most about 20, 18, 16, 14, 12, 10, 9, 8, and 7 mm (e.g., about 2.5-18 mm, about 3-10

mm, etc.). In certain embodiments, for example, the second group of three-dimensional surfaces may be taller than the first group of three-dimensional surfaces. In this regard, the first group of three-dimensional surfaces, while being shorter or smaller, according to certain embodiments may comprise a height from at least about any of the following: 1, 1.5, 2, 2.5, and 3 mm and/or at most about 19, 18, 16, 14, 12, 10, 9, 8, and 7 mm (e.g., about 2.5-18 mm, about 3-10 mm, etc.). In addition or alternatively to, the first and second groups of three-dimensional surfaces may comprise the same height, but comprise different areas of size. For example, the first group of three-dimensional surfaces may comprise the same height as the second group of three-dimensional surfaces, but the individual area of one or more (e.g., all) of the second group of three-dimensional surfaces may be larger than the individual area of one or more (e.g., all) of the first group of three-dimensional surfaces. In this regard, the second discrete region may comprise a larger percentage of area comprising a three-dimensional surface (e.g., bubble formation(s)) therein to provide a greater insulative capacity as compared to the first discrete region. In certain embodiments, the respective heights of the first and second group of three-dimensional surfaces may be the same or different (as discussed above), but the population density to the respective three-dimensional surfaces may be different to provide contrasting insulative capacities. For example, the first and second group of three-dimensional surfaces may (or may not) comprise the same shape (e.g., height, individual bubble area, etc.), but the second discrete region may comprise a greater number of individual three-dimensional surfaces per unit area of the article to provide insulative capacity greater than the insulative capacity of the first discrete region.

[0024] According to certain embodiments, for instance, the predetermined pattern may correspond to selected body region insulative requirements. As such, the seamless insulated article may comprise at least one of insulative portions, non-insulative portions, open mesh portions, or any combination thereof. In this regard, for example, each of the first discrete region and the second discrete region may correspond to at least one of a spinal cord area, spine, back area, an upper back area, a lower back area, a neck area, a knee back area, a chest front area, a breast area, an abdominal area, an armpit area, an arm area, an elbow front area, a sacrum dimple area, a groin area, a thigh area, a shin area, or any combination thereof. By way of example only, an arm area (e.g., elbow or shoulder) may have greater insulative requirements than an armpit area, and, as such, the arm area (e.g., elbow or shoulder) may comprise an insulative

portion of a seamless insulation article to keep the arm warm while an armpit area may comprise an open mesh portion of the seamless insulation article to promote ventilation in an area that produces more sweat than other body areas.

[0025] For example, Figures 6A-6G illustrate various seamless insulation articles in accordance with example embodiments. For instance, in some embodiments and as shown in Figures 6A-6B, the seamless insulation article 30 may comprise a seamless insulation shirt. For example, according to certain embodiments and as shown by comparing Figures 6A and 6B, the front side of the seamless insulation shirt (as shown in Figure 6A) may have a different three-dimensional surface pattern than the back side of the seamless insulation shirt (as shown in Figure 6B). In this regard, the seamless insulation shirt may have different insulation on the chest side from the back and/or shoulder regions, based at least in part of the chest side having a different pattern of three-dimensional surfaces than the back side of the shirt. In addition, the seamless insulation shirt may be loose fitting or tight fitting. Moreover, in other embodiments and as shown in Figure 6C, for example, the seamless insulation article 40 may comprise a seamless insulation glove. In further embodiments and as shown in Figure 6D, for instance, the seamless insulation article 50 may comprise a seamless insulation jacket. In other embodiments and as shown in Figure 6E, for example, the seamless insulation article 60 may comprise a seamless insulation sock. In further embodiments and as shown in Figure 6F, for instance, the seamless insulation article 70 may comprise a seamless insulation shoe. In this regard, seamless insulation articles according to certain embodiments may comprise an article or footwear in which the inner and outer surfaces can independently be tailored to match the required insulation as desired. In some embodiments and as shown in Figure 6G, for example, the seamless insulation article 80 may comprise seamless insulation pants.

[0026] In accordance with certain embodiments, for instance, the plurality of three-dimensional surfaces may comprise at least one of a bubble, a pile, a pillar, or any combination thereof. In further embodiments, for example, the plurality of three-dimensional surfaces may comprise at least one of a circular bubble, an elliptical bubble, a square bubble, a rectangular bubble, irregularly shaped bubble, or any combination thereof. As such, in some embodiments, for instance, the plurality of three-dimensional surfaces may comprise a three-dimensional domed shape from the side and any suitable geometry including, but not limited to, a circle, an ellipse, a square, a rectangle and/or the like when viewed from above the seamless insulation

article. Moreover, for example, the plurality of three-dimensional surfaces may comprise a combination of different geometries when viewed from above the seamless insulation article. In this regard, the geometries of the plurality of three-dimensional surfaces may be tailored to fit the insulative needs of a particular application or localized region of the seamless insulation article.

[0027] In accordance with certain embodiments, for instance, each of the first yarn and the second yarn may comprise at least one of a multifilament yarn, a spun fiber yarn, a monofilament yarn, or any combination thereof. In some embodiments, for example, each of the first yarn and the second yarn may comprise at least one of a synthetic yarn and/or fiber, a natural yarn and/or fiber, a regenerated yarn and/or fiber, yarns and/or fibers generated from natural products, or any combination thereof. In certain embodiments, for instance, synthetic yarns and/or fibers may comprise (but are not limited to) nylon yarns and/or fibers, acrylic yarns and/or fibers, polyester yarns and/or fibers, and polypropylene yarns and/or fibers. In further embodiments, for example, yarns having a natural source may be obtained from cotton, wool, flax, jute, bamboo, hemp, alpaca and/or the like. In certain embodiments, by way of example only, regenerated fibers may comprise rayon. In some embodiments, for instance, yarns derived from and/or manufactured from a natural source may be obtained from soy protein, corn, and the like. According to certain embodiments, for example, yarns having filament may have either a flat or textured form. For example, the yarns may comprise continuous flat filaments, continuous textured filaments, spun yarns comprising synthetic staple fibers and/or the like. Examples of such filament forms of yarn may include, but are not limited to, nylon, polyester, polypropylene and/or the like. The various yarns described herein, for instance, may be used individually or in combination with each other. In some exemplary embodiments, for example, the first yarn and the second yarn may comprise the same color or different colors and may comprise different dyeability. By way of example only, in such embodiments, the first yarn may comprise, for example, nylon, while the second yarn may comprise a cationic dyeable polyester. Further, the yarn combinations may be formed, for example, in the knitting process or in a separate process prior to the knitting process.

[0028] According to certain embodiments, for instance, the seamless insulation article may further comprise an elastomeric yarn. In some embodiments, for example, the elastomeric yarn may comprise at least one of rubber, spandex or other elastic material such as Lycra® fiber. In certain embodiments, for instance, the elastomeric yarn may be incorporated into the seamless

insulation article by being laid-in, knit-in and/or the like. Moreover, in some embodiments, for example, the elastomeric yarn may comprise bare spandex laid-in or plaited with the knit base and/or second yarn. In further embodiments, for instance, the spandex and/or rubber may be commingled with other fibers (e.g., nylon, polyester, polypropylene, etc.) to form a synthetic filament yarn. In other embodiments, for example, the spandex and/or rubber may be covered by at least one of filament yarn, spun yarn (e.g., natural fibers like cotton, wool, etc. or a blend of natural fibers with synthetic fibers such as a polyester/cotton blend) and/or the like. In further embodiments, for instance, the elastomeric yarn may further comprise a covering of flat and/or textured filament yarns such as nylon, polyester or polypropylene. According to certain embodiments, for example, the elastomeric yarn may be utilized to form the plurality of three-dimensional surfaces.

[0029] In accordance with certain embodiments, for example, the seamless insulation article may further comprise at least one smart yarn. In such embodiments, for instance, the at least one smart yarn may comprise at least two polymers having different relative shrinkages when exposed to heat (e.g., dry and/or wet heat during, for example, steaming or dyeing). In certain embodiments, the three-dimensional surfaces may be formed by exploiting the different relative shrinkages. For instance, the differential shrinkage between the two polymers when exposed to heat may enhance the three-dimensional configuration generated by the knit structure containing, for example only, spandex. In further embodiments, for example, the at least one smart yarn may further comprise at least one of a ceramic (e.g., zirconium carbide), a synthetic material, a phase change material (e.g., phase change polymer), a biomimetric material, or any combination thereof.

[0030] According to certain embodiments, for instance, the seamless insulation article may further comprise at least one of a softener, an antimicrobial treatment, a wicking treatment, a soil release treatment, a water repellent, an oil repellent, a fire retardant, or any combination thereof. In this regard, in example embodiments, for instance, odor may be reduced in the seamless insulation article via treatment with at least one durable antimicrobial. Further exemplary embodiments may utilize a wicking treatment in order to increase the surface tension of the seamless insulated article in order to better enable moisture (e.g., liquid sweat) to move in between yarn filaments and/or fiber bundles. In addition, some example embodiments, for instance, may incorporate a soil release treatment into the seamless insulated article in order to

facilitate stain removal. Moreover, in regard to softeners, for example, the skin surface of the seamless insulation article may be softened by at least one of a softener or mechanical softening (e.g., sanding, brushing and/or the like). In example embodiments utilizing mechanical softening, for instance, mechanical softening may be performed on the seamless insulation article as a finishing process and/or on the second yarn prior to knitting.

[0031] Thus, the invention includes seamless insulation articles suitable for a wide variety of uses (e.g., garments, footwear, home textile articles, etc.). In accordance with certain embodiments, the seamless insulation article may include a knit base comprising a first yarn and a second yarn incorporated into a continuous web defined by the first yarn and the second yarn in a predetermined pattern to form a plurality of three-dimensional surfaces. The plurality of three-dimensional surfaces may define at least two discrete regions having different contrasting insulative capacities arranged in the predetermined pattern such that the at least two discrete regions may comprise a first discrete region and a second discrete region. The first discrete region may comprise a first insulative capacity, the second discrete region may comprise a second insulative capacity, and the second insulative capacity may be greater than the first insulative capacity.

[0032] In another aspect, certain embodiments of the invention provide a method for making a seamless insulation article. In accordance with certain embodiments, the method includes combining a first yarn and a second yarn in a continuous web in a predetermined pattern and finishing at least one surface of the continuous web to form a plurality of three-dimensional surfaces. The plurality of three-dimensional surfaces, for example, may define at least two discrete regions having different contrasting insulative capacities arranged in the predetermined pattern such that the at least two discrete regions may comprise a first discrete region and a second discrete region. For instance, the first discrete region may comprise a first insulative capacity, the second discrete region may comprise a second insulative capacity, and the second insulative capacity may be greater than the first insulative capacity.

[0033] Figure 7, for example, illustrates a process flow diagram for making a seamless insulation article according to an example embodiment. As shown in Figure 7, the method may include an initial optional step of designing the predetermined pattern at operation 110. Next, the method may proceed by combining a first yarn and a second yarn in a continuous web in a predetermined pattern at operation 120 and finishing at least one surface of the continuous web

to form a plurality of three-dimensional surfaces at operation 130. Then, the method may include the optional steps of combining (e.g., laminating, stitching, etc.) the seamless insulated article with a second article at operation 140 and removing the seamless insulated article from the continuous web according to the predetermined pattern at operation 150.

[0034] According to certain embodiments, for instance, combining a first yarn and a second yarn in a continuous web in a predetermined pattern may comprise at least one of tubular circular knitting, plaiting, reverse plaiting, warp knitting, weaving, or any combination thereof. In further embodiments, for example, combining a first yarn and a second yarn in a continuous web in a predetermined pattern may comprise at least one of tubular circular knitting and warp knitting on a whole seamless silhouette machine (e.g., Santoni® seamless knitting machine, Shima Seiki® knitting machine, etc.). In other embodiments, for instance, the second yarn may be plaited with the first yarn. In this regard, in some embodiments, for example, loosely plaiting the second yarn with the first yarn may form the plurality of three-dimensional surfaces. In further embodiments, for example, the first yarn and the second yarn may be combined via regular plaiting, and one surface of the continuous web may be finished to form a single face fleece. In other embodiments, for instance, the first yarn and the second yarn may be combined via reverse plaiting, and both surfaces of the continuous web may be finished to form a double face fleece. By way of example only, combining a first yarn and a second yarn in a continuous web in a predetermined pattern may comprise forming loop yarn to a first pile height in a first discrete region and forming loop yarn to a second pile height in a second discrete region such that the second pile height is greater than the first pile height. In some embodiments, for instance, forming loop yarn to a first pile height may comprise forming loop yarn with no pile.

[0035] In other exemplary embodiments, however, forming loop yarn to a first pile height may comprise forming loop yarn to a low pile height using, by way of example only, shrinkable yarn. In such embodiments, for example, the first yarn may comprise a first shrinkage and the second yarn may comprise a second shrinkage being different from the first shrinkage to define a differential relative shrinkage between the first yarn and the second yarn when exposed to heat. In certain embodiments, the three-dimensional surfaces may be formed by exploiting the differential relative shrinkages. By way of example only, yarns according to example embodiments may comprise bicomponent polymer yarns. In such embodiments, for instance, there may be a differential relative shrinkage between flat polyester filament yarns and textured

polyester filament yarns. In other embodiments, for example, there may be a differential relative shrinkage between a heat set textured polyester filament yarn and a non-heat set textured polyester filament yarn. In further embodiments, for instance, there may be a differential relative shrinkage between a high heat set textured polyester filament yarn and a low heat set textured polyester filament yarn. Moreover, polyester filament yarns having different deniers may also exhibit a differential relative shrinkage.

[0036] According to certain embodiments, for example, combining a first yarn and a second yarn in a continuous web in a predetermined pattern may further comprise incorporating at least one smart yarn into the continuous web. By way of example only, the at least one smart yarn may be incorporated into the continuous web in the first discrete region in which the loop yarn is formed to the first pile height and/or the second discrete region in which the loop yarn is formed to the second pile height. In some example embodiments, for instance, the at least one smart yarn may be utilized as stitch yarns in the second discrete region in which the loop yarn is formed to the second pile height. Moreover, in further embodiments, for example, the at least one smart yarn may be incorporated into the continuous web as a floating yarn in the first discrete region in which the loop yarn is formed to the first pile height. In such embodiments, for instance, the floating yarn is anchored to the continuous web in the segments between the three-dimensional surfaces that define the plurality of air channels. In certain embodiments and as previously discussed, for instance, the at least one smart yarn may comprise at least one of a ceramic (e.g., zirconium carbide), a synthetic material, a phase change material (e.g., phase change polymer), a biomimetric material, or any combination thereof. In further embodiments, for example, an elastomeric material may be incorporated (e.g., plaited, commingled, warp knitted, etc.) into the continuous web.

[0037] In accordance with certain embodiments, for example, the method may further comprise designing the predetermined pattern, combining (e.g., laminating, stitching, etc.) the seamless insulated article with a second article, and removing the seamless insulated article from the continuous web according to the predetermined pattern. In some embodiments, for instance, designing the predetermined pattern may comprise designing the predetermined pattern for use in at least one of a jacket, a shirt, a pair of pants, a pair of shorts, a glove, a mitt, a sock, a shoe, a shoe insert, a blanket, a mattress cover, a mattress ticking, or any combination thereof. In some example embodiments, for instance, laminating (or otherwise attaching or combining) the

seamless insulated article with a second article may comprise laminating (or otherwise attaching or combining) the seamless insulated article with a complementary seamless article having a complementary pattern of three-dimensional surfaces or other non-seamless article if so desired. In such embodiments, for instance, in order to laminate the seamless insulated article with a complementary seamless article (or non-seamless article if so desired), a tubular seamless knit may be slit so as to laminate the open width of the seamless article. For example, the second article may comprise a controlled air permeability element (e.g., a windbreaker, jacket and/or the like). In further embodiments, for example, removing the seamless insulated article from the continuous web according to the predetermined pattern may comprise cutting the seamless insulated article out of the continuous web based on the pattern of the plurality of three-dimensional surfaces. For example, a seamless insulated article having a predetermined pattern of the plurality of three-dimensional surfaces appropriate for a seamless insulated jacket may be cut from the continuous web to isolate the seamless insulated jacket.

[0038] In accordance with certain embodiments, for instance, the method may be directed to forming a seamless insulation article system. In such embodiments, for example, the method may comprise forming a first seamless insulation article, forming at least one additional article (e.g., an additional insulation article), and overlying the first seamless insulation article with the at least one additional article (e.g., an additional insulation article). In this regard, the seamless insulation article system may provide a system comprising thin layers that provide, for example, insulation, breathability, and moisture management while preventing chafing. In this regard, certain embodiments may comprise a single layer article or a multi-layered article.

[0039] Although exemplary knitting processes have been described herein, one of ordinary skill in the art should understand that this disclosure is not limited to such knitting processes. In fact, any knitting process suitable for producing the seamless insulation article described herein as understood by one of ordinary skill in the art may be used. Moreover, all disclosures regarding the seamless insulation article are hereby incorporated into the method disclosures discussed herein.

[0040] In this regard, the seamless insulation article may allow a user to keep selected regions of the body warm, while allowing other regions of the body to be cooled by evaporation and/or ventilation. By way of example only, selected regions such as the arms or lower back may be made to have higher insulative capacity to keep athletes warm. In some embodiments, for

example, either the right arm or the left arm may be more insulating in order to keep the throwing arm of a pitcher warm while allowing the rest of the body to be cool. Moreover, the formation of the seamless insulation article as complementary single layer elements may reduce cutting and sewing costs and fabric wastage, and utilizing a seamless insulation article reduces potential failure points and also may reduce chafing on the user's skin. Extremely intricate patterns of varying thickness may be achieved and used to create infinitely varied regions of insulating warmth, range of motion, and breathability in the fabric that may be customized for any number of physical activities.

[0041] In addition, similar advantages may be provided by seamless insulation articles in the form of home textile articles, such as bed sheets and mattress covers utilized in, for example, furniture for home, institutional, and commercial markets, including transportation seating. For example, home textile articles may be configured to provide discrete regions of insulation performance in a pattern corresponding to insulation requirements of a user's body. By way of example only, seamless insulation articles utilized as mattress covers may be configured to provide discrete regions offering improved breathability, ventilation, and reduced sweat for different regions of a user's body (e.g., the user's back). As such, the seamless insulation articles disclosed herein may provide insulation, breathability, and moisture management while preventing chafing in a variety of applications including, but not limited to, garments, home textile articles and/or the like.

[0042] Non-limiting Exemplary Embodiments

[0043] Having described various aspects and embodiments of the invention herein, further specific embodiments of the invention include those set forth in the following paragraphs.

[0044] Certain embodiments according to the invention provide seamless insulation articles suitable for a wide variety of uses (e.g., garments, footwear, home textile articles, etc.). In accordance with certain embodiments, the seamless insulation article includes a knit base comprising a first yarn and a second yarn incorporated into a continuous web defined by the first yarn and the second yarn in a predetermined pattern to form a plurality of three-dimensional surfaces. The plurality of three-dimensional surfaces define at least two discrete regions having different contrasting insulative capacities arranged in the predetermined pattern, said at least two discrete regions comprising a first discrete region and a second discrete region. The first discrete

region comprises a first insulative capacity, the second discrete region comprises a second insulative capacity, and the second insulative capacity is greater than the first insulative capacity.

[0045] In accordance with certain embodiments, the plurality of three-dimensional surfaces defines a plurality of air channels therebetween. Moreover, in some embodiments, the seamless insulation article comprises an outer surface and a skin surface, the outer surface comprises a smooth topography, and the plurality of three-dimensional surfaces is disposed on the skin surface and defines a three-dimensional topography. In certain embodiments, the plurality of three-dimensional surfaces comprises at least a first group of three-dimensional surfaces and a second group of three-dimensional surfaces, the second group of three-dimensional surfaces comprises a height from about 1 mm to about 20 mm, and the second group of three-dimensional surfaces is taller than the first group of three-dimensional surfaces. In such embodiments, the first discrete region comprises the first group of three-dimensional surfaces, and the second discrete region comprises the second group of three-dimensional surfaces. In some embodiments, the plurality of three-dimensional surfaces comprises at least one of a bubble, a pile, a pillar, or any combination thereof. In further embodiments, the plurality of three-dimensional surfaces comprises at least one of a circular bubble, an elliptical bubble, a square bubble, a rectangular bubble, or any combination thereof.

[0046] According to certain embodiments, the predetermined pattern corresponds to selected body region insulative requirements. In this regard, each of the first discrete region and the second discrete region correspond to at least one of a spinal cord area, back area, an upper back area, a lower back area, a neck area, a knee back area, a chest front area, a breast area, an abdominal area, an armpit area, an arm area, an elbow front area, a sacrum dimple area, a groin area, a thigh area, a shin area, or any combination thereof.

[0047] In accordance with certain embodiments, each of the first yarn and the second yarn comprise at least one of a synthetic fiber, a natural fiber, a regenerated fiber, or any combination thereof. In some embodiments, each of the first yarn and the second yarn comprise at least one of a multifilament yarn, a spun fiber yarn, a monofilament yarn, or any combination thereof. In other embodiments, the seamless insulation article further comprises an elastomeric yarn. In some embodiments, the first yarn comprises a first shrinkage and the second yarn comprises a second shrinkage being different from the first shrinkage to define a differential relative shrinkage between the first yarn and the second yarn when exposed to heat. In further

embodiments, the seamless insulation article further comprises at least one smart yarn, wherein the at least one smart yarn comprises at least one of a ceramic, a synthetic material, a phase change material, a biomimetric material, or any combination thereof. In further embodiments, the seamless insulation article further comprises at least one of a softener, an antimicrobial treatment, a wicking treatment, a soil release treatment, a water repellent, an oil repellent, a fire retardant, or any combination thereof.

[0048] In another aspect, certain embodiments according to the invention provide methods for making seamless insulation articles. In accordance with certain embodiments, the method includes combining a first yarn and a second yarn in a continuous web in a predetermined pattern and finishing at least one surface of the continuous web to form a plurality of three-dimensional surfaces. The plurality of three-dimensional surfaces define at least two discrete regions having different contrasting insulative capacities arranged in the predetermined pattern, said at least two discrete regions comprising a first discrete region and a second discrete region. The first discrete region comprises a first insulative capacity, the second discrete region comprises a second insulative capacity, and the second insulative capacity is greater than the first insulative capacity. In some embodiments, combining a first yarn and a second yarn in a continuous web in a predetermined pattern comprises at least one of tubular circular knitting, plaiting, reverse plaiting, warp knitting, weaving, or any combination thereof. According to certain embodiments, combining a first yarn and a second yarn in a continuous web in a predetermined pattern further comprises incorporating at least one smart yarn into the continuous web, said at least one smart yarn comprising at least one of a ceramic, a synthetic material, a phase change material, a biomimetric material, or any combination thereof. In further embodiments, the method further comprises designing the predetermined pattern, laminating the seamless insulated article with a second article, and removing the seamless insulated article from the continuous web according to the predetermined pattern. In some embodiments, designing the predetermined pattern comprises designing the predetermined pattern for use in at least one of a jacket, a shirt, a pair of pants, a pair of shorts, a glove, a mitt, a sock, a shoe, a shoe insert, a blanket, a mattress cover, a mattress ticking, or any combination thereof.

[0049] These and other modifications and variations to the invention may be practiced by those of ordinary skill in the art without departing from the spirit and scope of the invention, which is more particularly set forth in the appended claims. In addition, it should be understood

that aspects of the various embodiments may be interchanged in whole or in part. Furthermore, those of ordinary skill in the art will appreciate that the foregoing description is by way of example only, and it is not intended to limit the invention as further described in such appended claims. Therefore, the spirit and scope of the appended claims should not be limited to the exemplary description of the versions contained herein.

THAT WHICH IS CLAIMED:

1. A seamless insulation article, comprising:

a knit base comprising a first yarn; and

a second yarn incorporated into a continuous web defined by the first yarn and the second yarn in a predetermined pattern to form a plurality of three-dimensional surfaces,

wherein the plurality of three-dimensional surfaces defines at least two discrete regions having different contrasting insulative capacities arranged in the predetermined pattern, said at least two discrete regions comprising a first discrete region and a second discrete region, and

wherein the first discrete region comprises a first insulative capacity, the second discrete region comprises a second insulative capacity, and the second insulative capacity is greater than the first insulative capacity.

2. The seamless insulation article according to claim 1, wherein the plurality of three-dimensional surfaces defines a plurality of air channels therebetween.

3. The seamless insulation article according to claim 1, wherein the seamless insulation article comprises an outer surface and a skin surface, the outer surface comprises a smooth topography, and the plurality of three-dimensional surfaces is disposed on the skin surface and defines a three-dimensional topography.

4. The seamless insulation article according to claim 1, wherein the plurality of three-dimensional surfaces comprises at least a first group of three-dimensional surfaces and a second group of three-dimensional surfaces, the second group of three-dimensional surfaces comprises a height from about 1 mm to about 20 mm, and the second group of three-dimensional surfaces is taller than the first group of three-dimensional surfaces.

5. The seamless insulation article according to claim 4, wherein the first discrete region comprises the first group of three-dimensional surfaces, and the second discrete region comprises the second group of three-dimensional surfaces.

6. The seamless insulation article according to claim 1, wherein the plurality of three-dimensional surfaces comprises at least one of a bubble, a pile, a pillar, or any combination thereof.

7. The seamless insulation article according to claim 1, wherein the plurality of three-dimensional surfaces comprises at least one of a circular bubble, an elliptical bubble, a square bubble, a rectangular bubble, irregularly-shaped bubble, or any combination thereof.

8. The seamless insulation article according to claim 1, wherein the predetermined pattern corresponds to selected body region insulative requirements.

9. The seamless insulation article according to claim 1, wherein each of the first discrete region and the second discrete region correspond to at least one of a spinal cord area, back area, an upper back area, a lower back area, a neck area, a knee back area, a chest front area, a breast area, an abdominal area, an armpit area, an arm area, an elbow front area, a sacrum dimple area, a groin area, a thigh area, a shin area, or any combination thereof.

10. The seamless insulation article according to claim 1, wherein each of the first yarn and the second yarn comprise at least one of a synthetic fiber, a natural fiber, a regenerated fiber, or any combination thereof.

11. The seamless insulation article according to claim 1, wherein each of the first yarn and the second yarn comprise at least one of a multifilament yarn, a spun fiber yarn, a monofilament yarn, or any combination thereof.

12. The seamless insulation article according to claim 1, further comprising at least one elastomeric yarn.

13. The seamless insulation article according to claim 1, wherein the first yarn comprises a first shrinkage and the second yarn comprises a second shrinkage being different from the first shrinkage to define a differential relative shrinkage between the first yarn and the second yarn when exposed to heat.

14. The seamless insulation article according to claim 1, further comprising at least one smart yarn, said at least one smart yarn comprising at least one of a ceramic, a synthetic material, a phase change material, a biomimetric material, or any combination thereof.

15. The seamless insulation article according to claim 1, further comprising at least one of a softener, an antimicrobial treatment, a wicking treatment, a soil release treatment, a water repellent, an oil repellent, a fire retardant, or any combination thereof.

16. A method for making a seamless insulation article, comprising:

combining a first yarn and a second yarn in a continuous web in a predetermined pattern; and

finishing at least one surface of the continuous web to form a plurality of three-dimensional surfaces,

wherein the plurality of three-dimensional surfaces define at least two discrete regions having different contrasting insulative capacity arranged in the predetermined pattern, said at least two discrete regions comprising a first discrete region and a second discrete region, and

wherein the first discrete region comprises a first insulative capacity, the second discrete region comprises a second insulative capacity, and the second insulative capacity is greater than the first insulative capacity.

17. The method according to claim 16, wherein combining a first yarn and a second yarn in a continuous web in a predetermined pattern comprises at least one of tubular circular knitting, plaiting, reverse plaiting, warp knitting, weaving, or any combination thereof.

18. The method according to claim 16, wherein combining a first yarn and a second yarn in a continuous web in a predetermined pattern further comprises incorporating at least one smart yarn into the continuous web, said at least one smart yarn comprising at least one of a ceramic, a synthetic material, a phase change material, a biomimetric material, or any combination thereof.

19. The method according to claim 16, further comprising:

designing the predetermined pattern;

laminating the seamless insulated article with a second article; and

removing the seamless insulated article from the continuous web according to the predetermined pattern.

20. The method according to claim 19, wherein designing the predetermined pattern comprises designing the predetermined pattern for use in at least one of a jacket, a shirt, a pair of pants, a pair of shorts, a glove, a mitt, a sock, a shoe, a shoe insert, a blanket, a mattress cover, a mattress ticking, or any combination thereof.

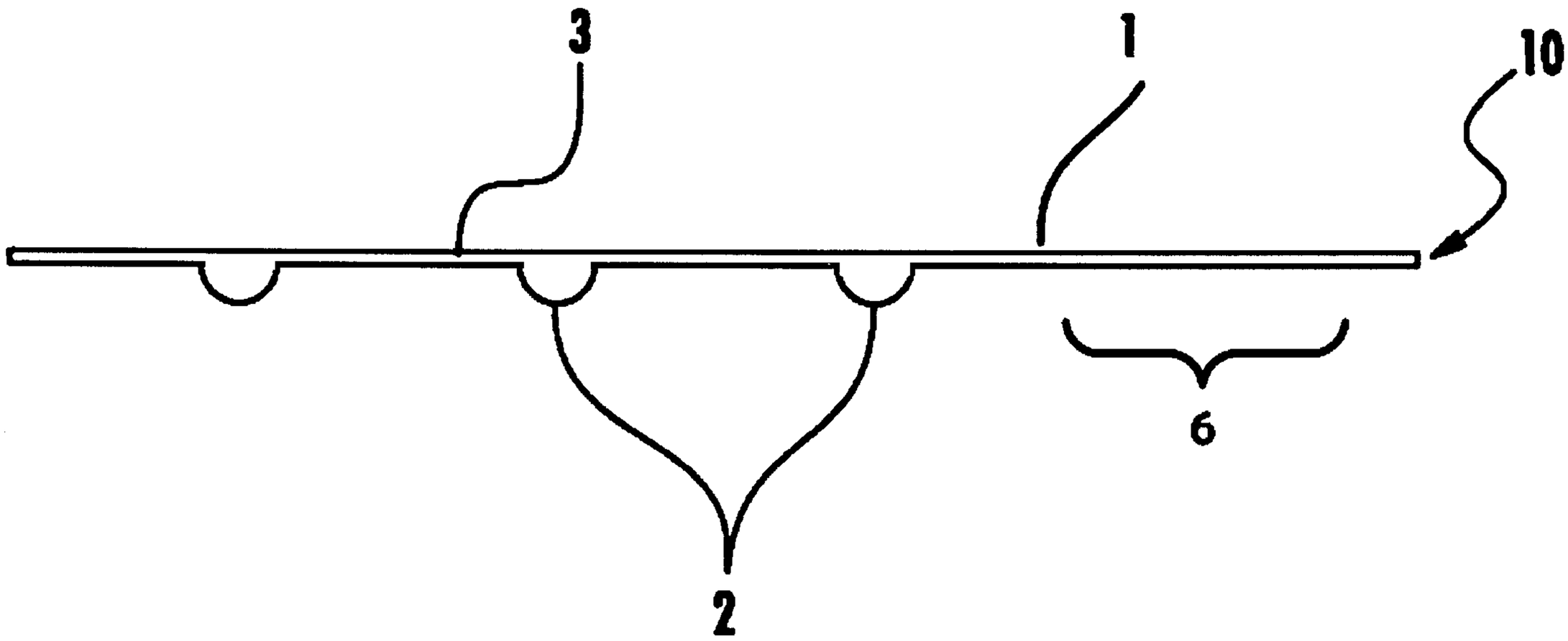


FIG. 1

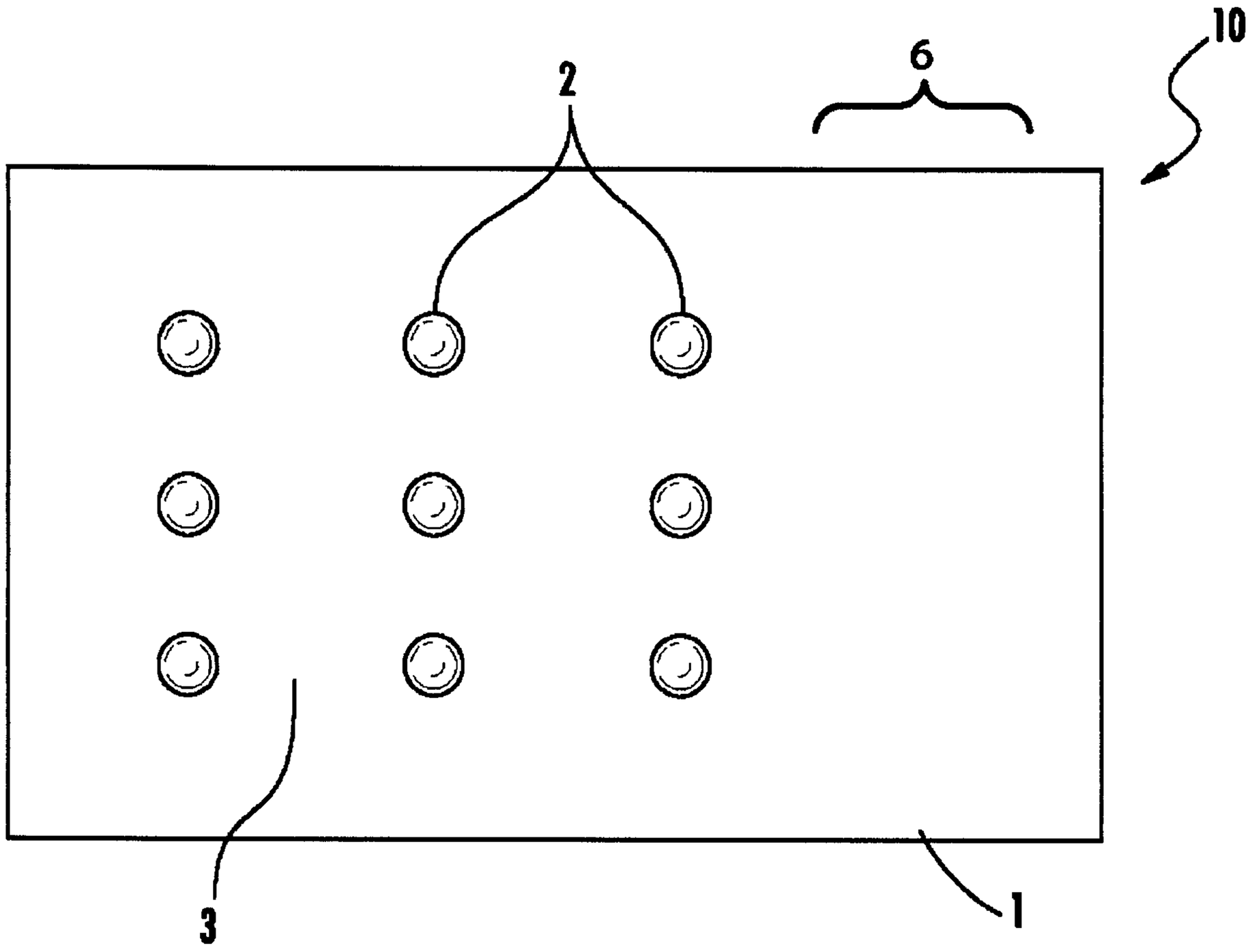


FIG. 2

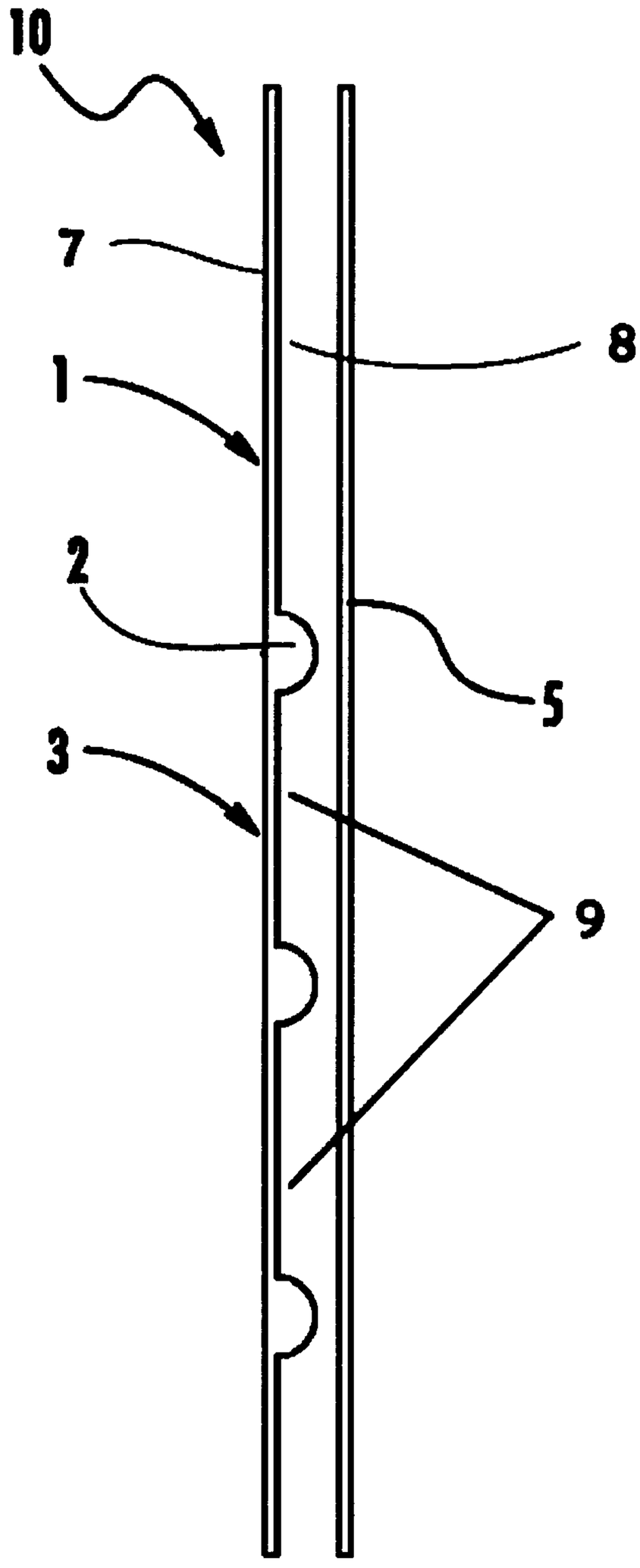


FIG. 3

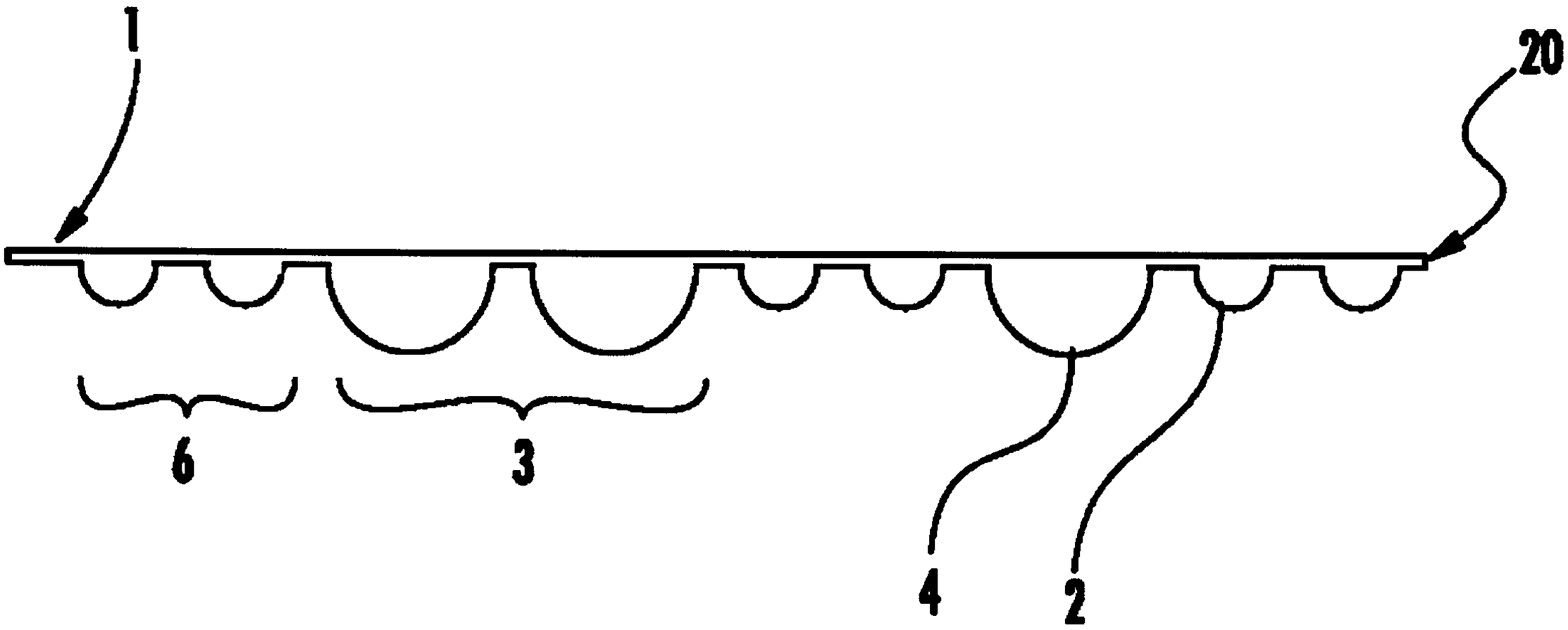


FIG. 4

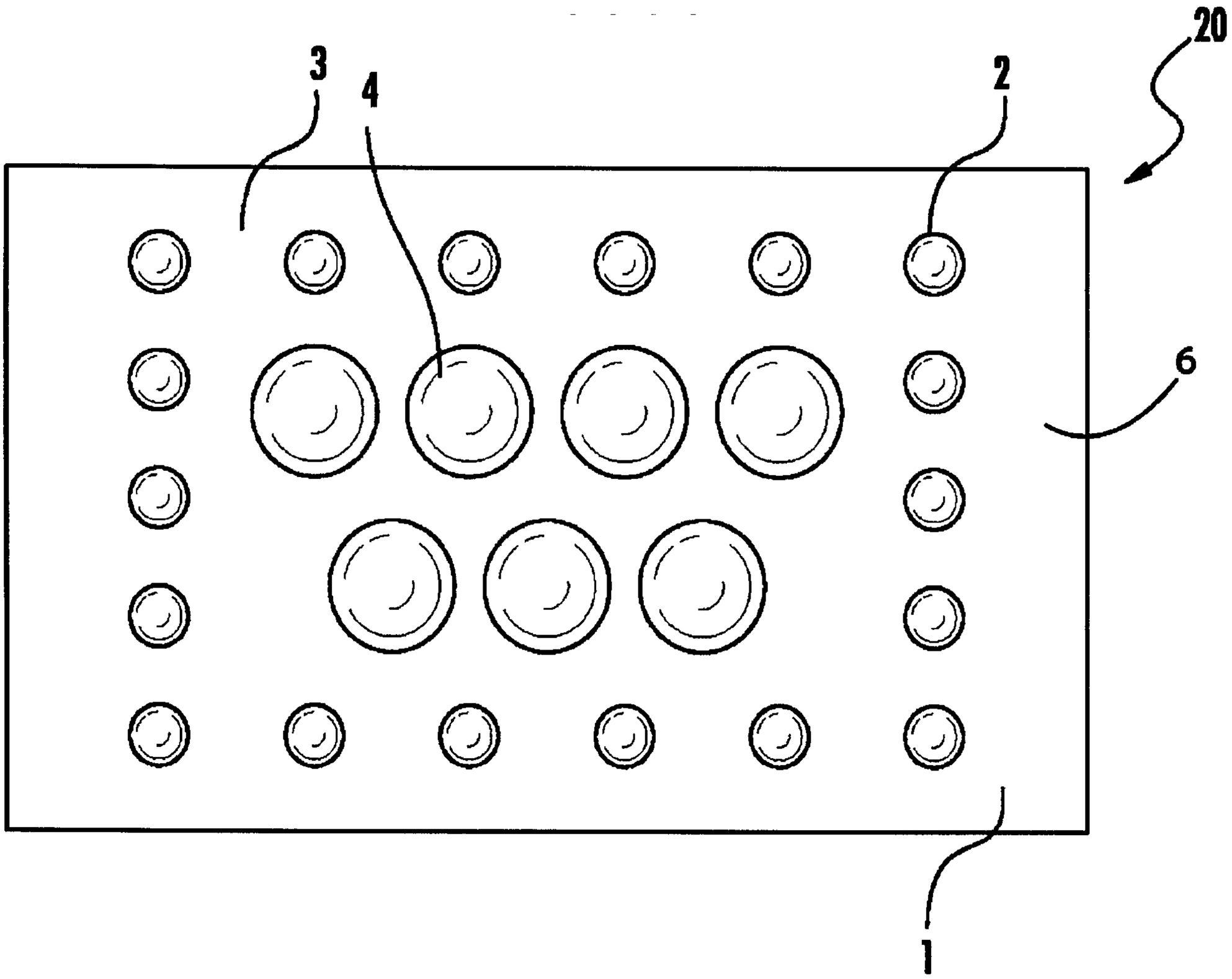


FIG. 5

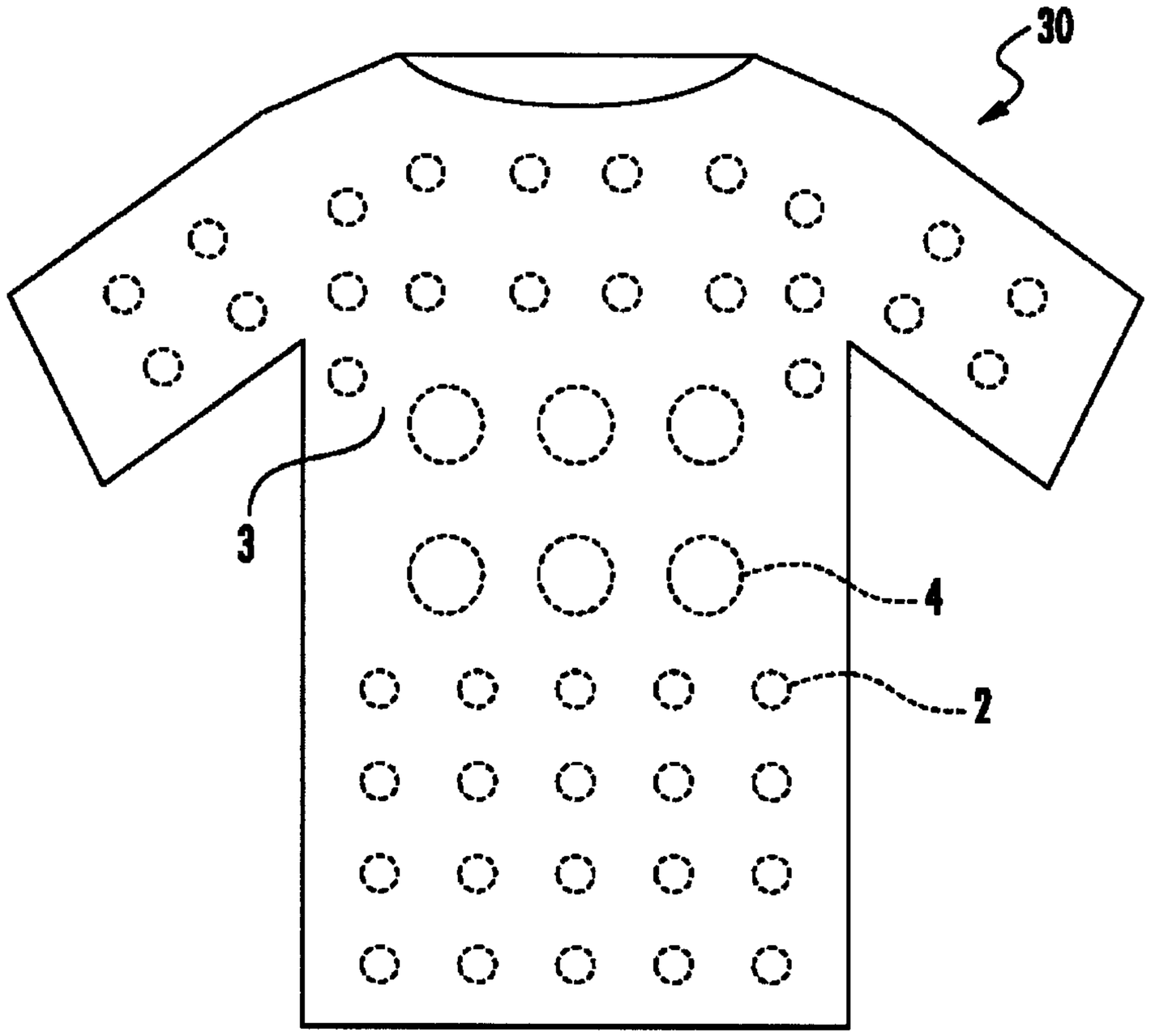
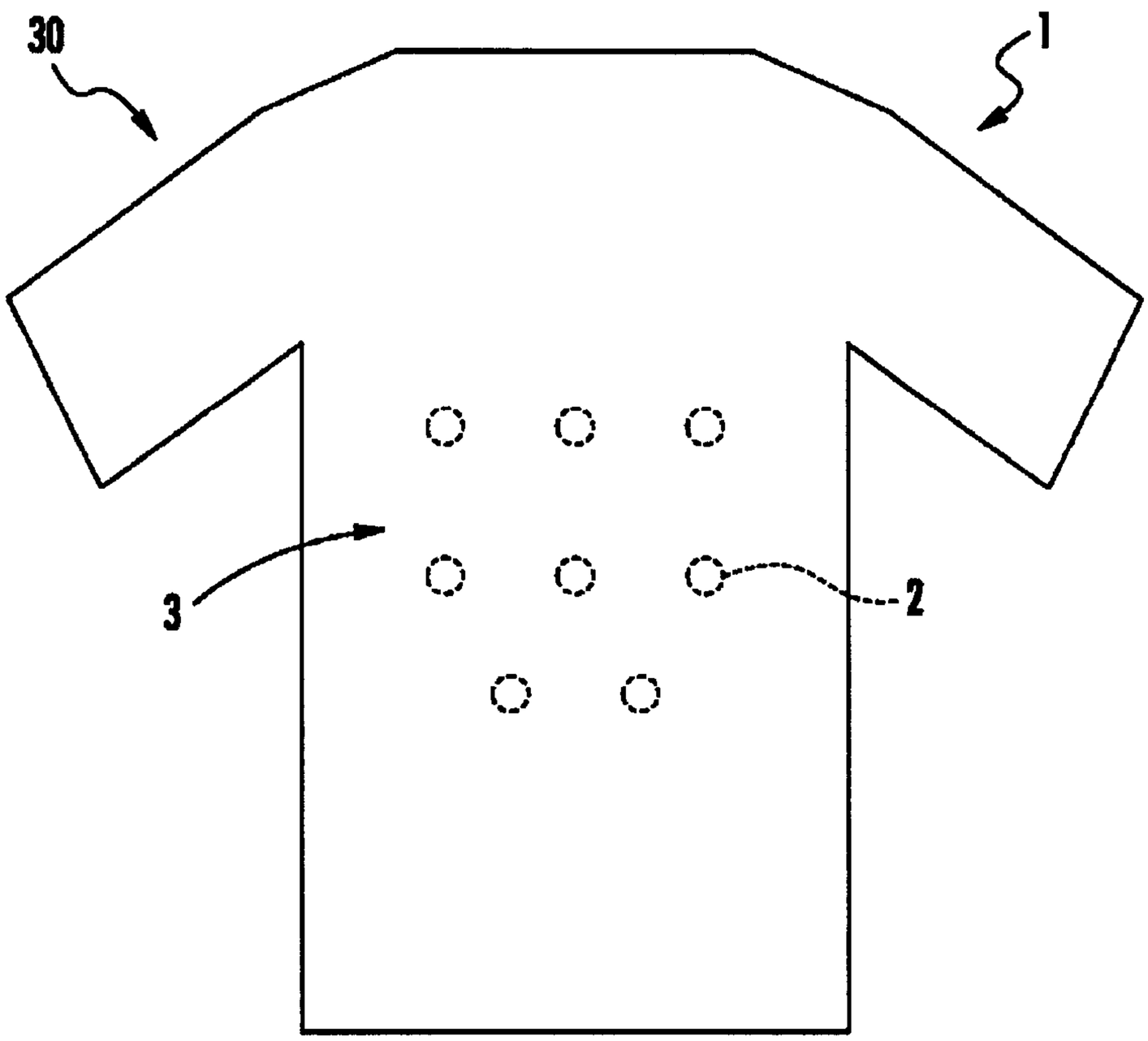


FIG. 6A



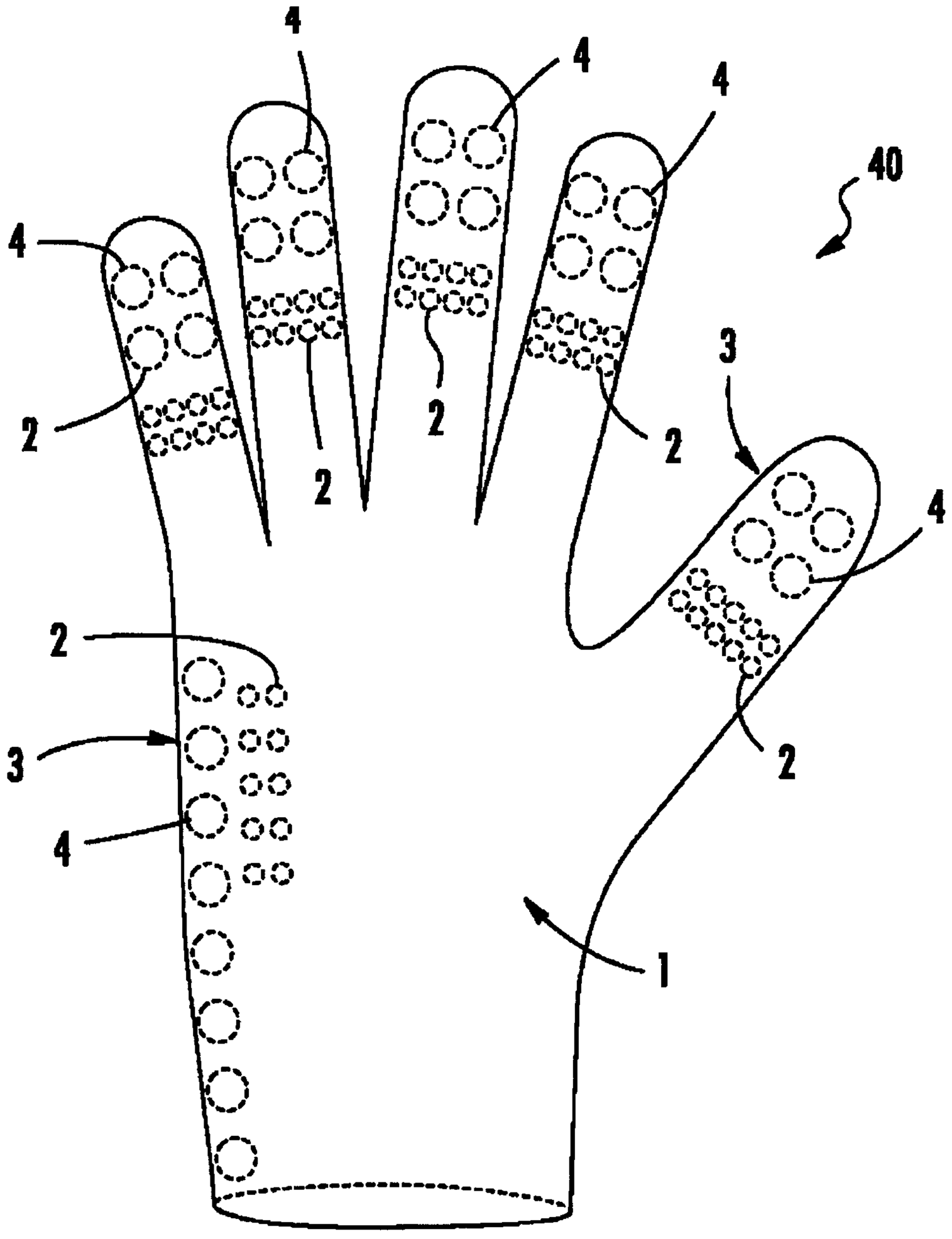


FIG. 6C

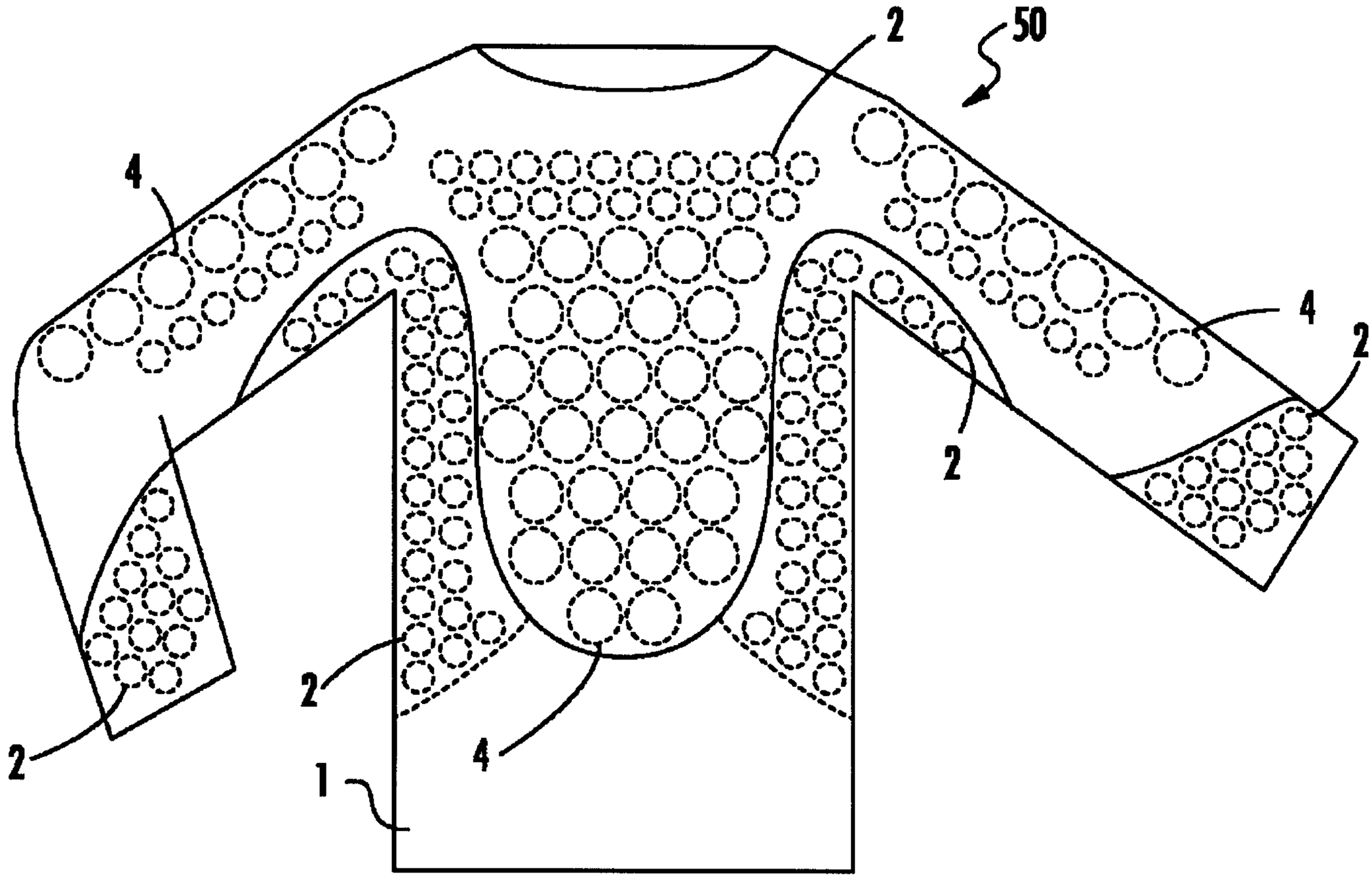


FIG. 6D

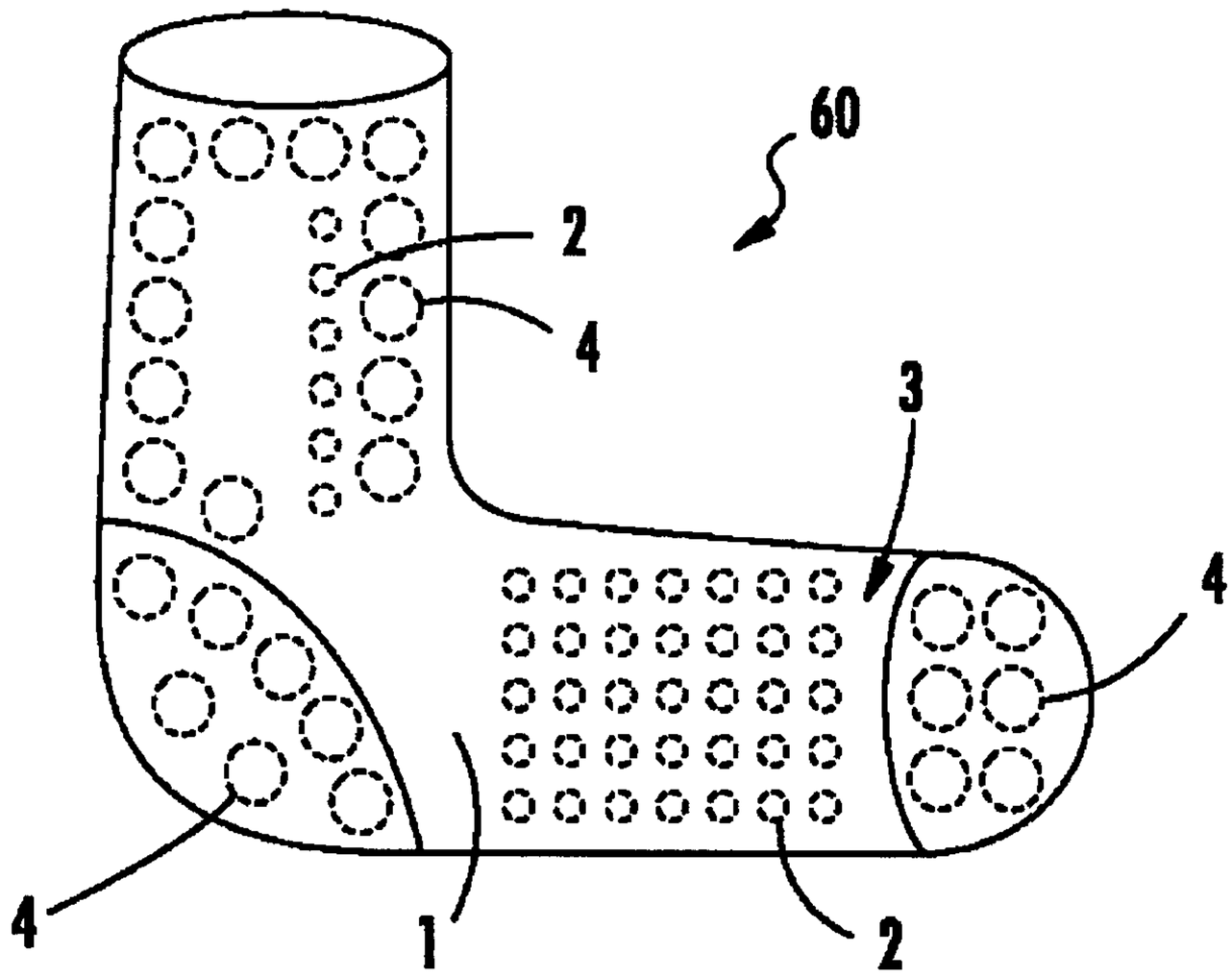


FIG. 6E

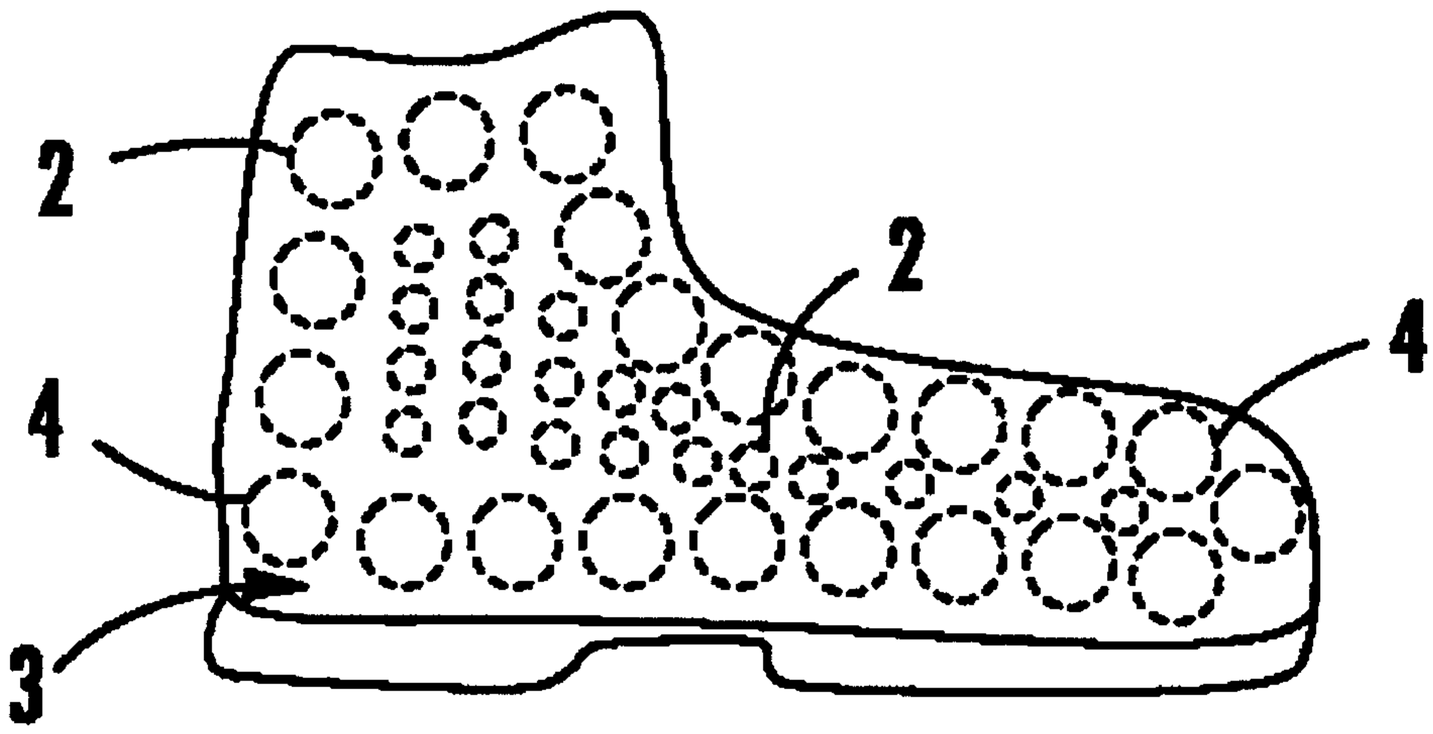


FIG. 6F

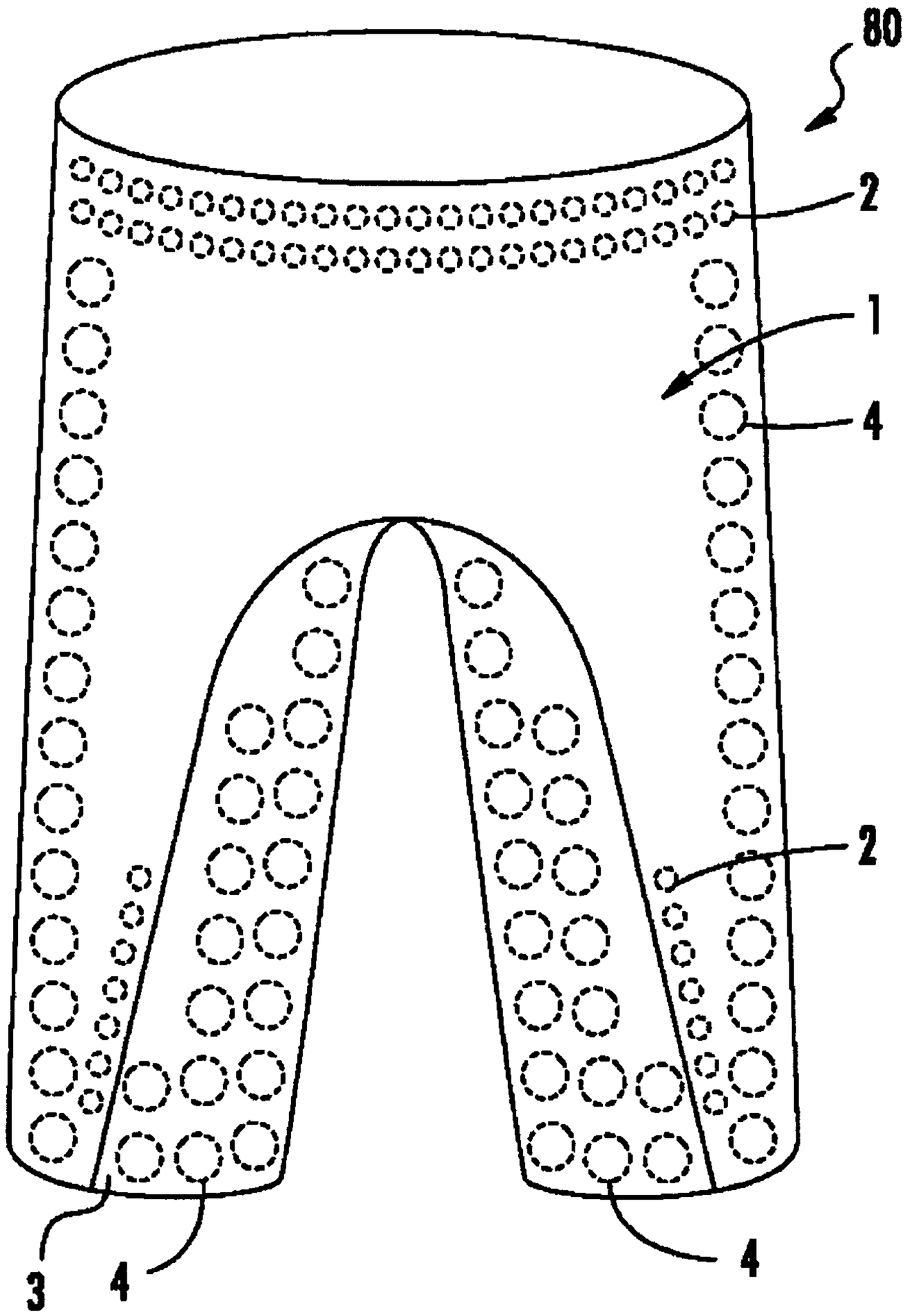


FIG. 6G

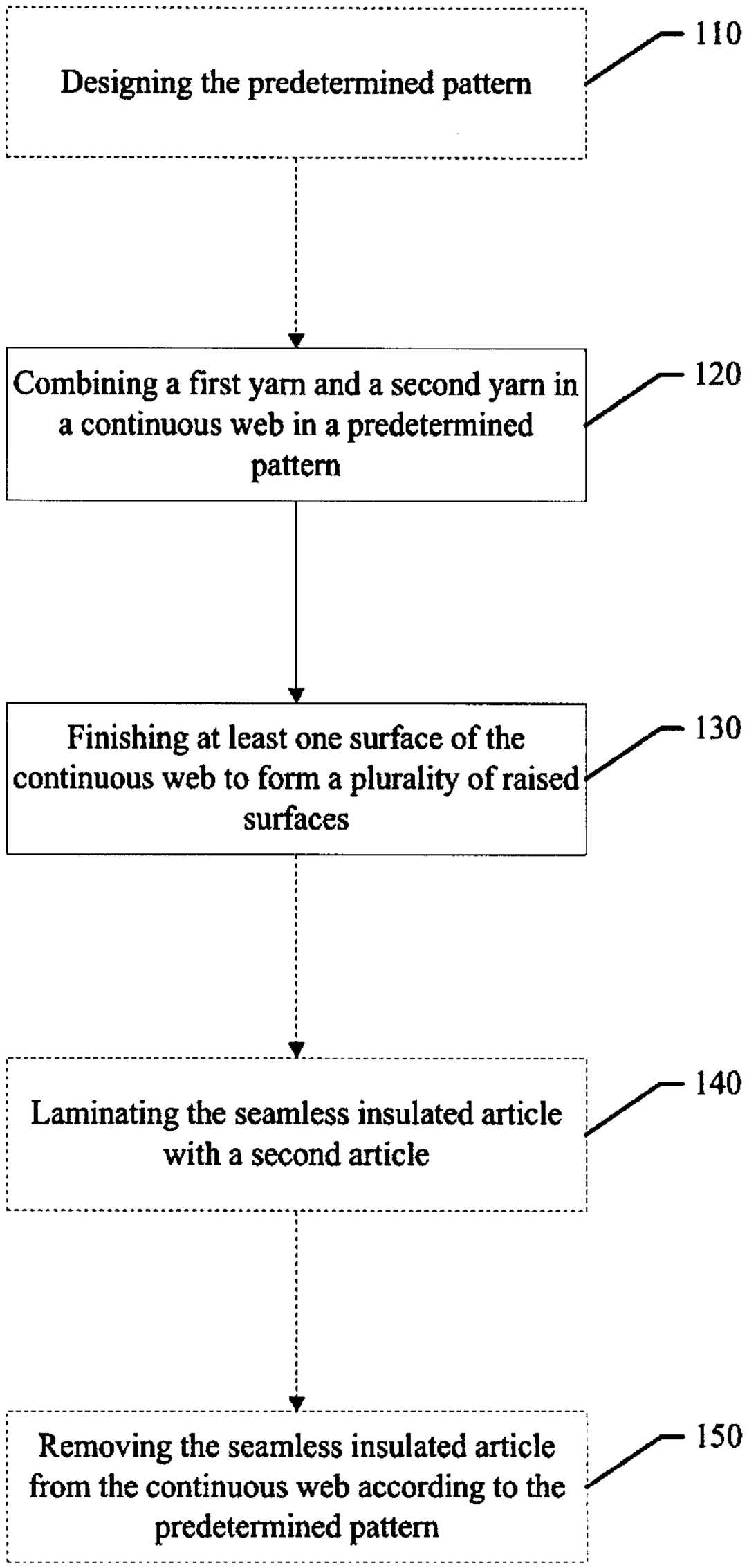
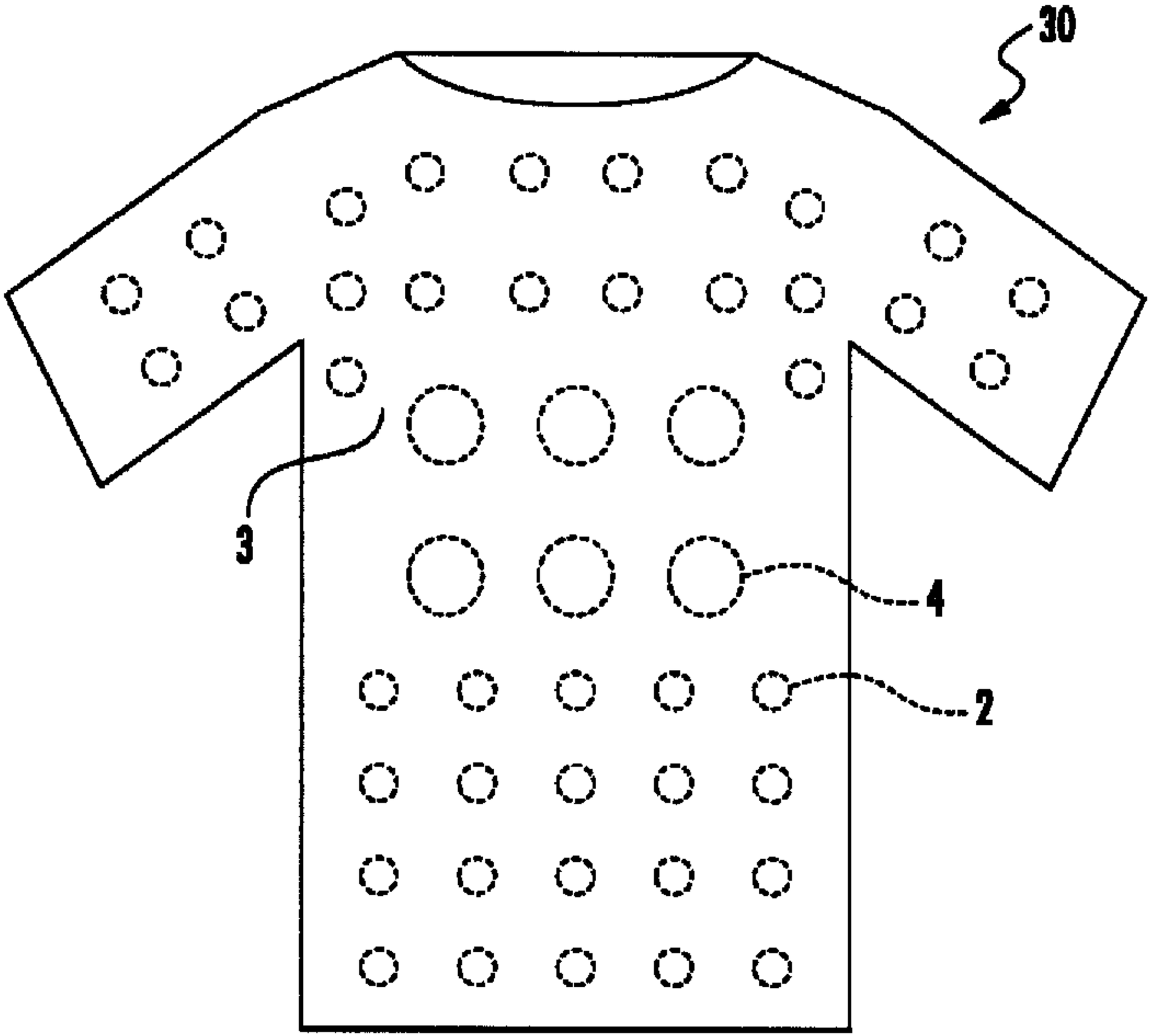

Designing the predetermined pattern
110
Combining a first yarn and a second yarn in a continuous web in a predetermined pattern
120
Finishing at least one surface of the continuous web to form a plurality of raised surfaces
130
Laminating the seamless insulated article with a second article
140
Removing the seamless insulated article from the continuous web according to the predetermined pattern
150

FIG. 7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