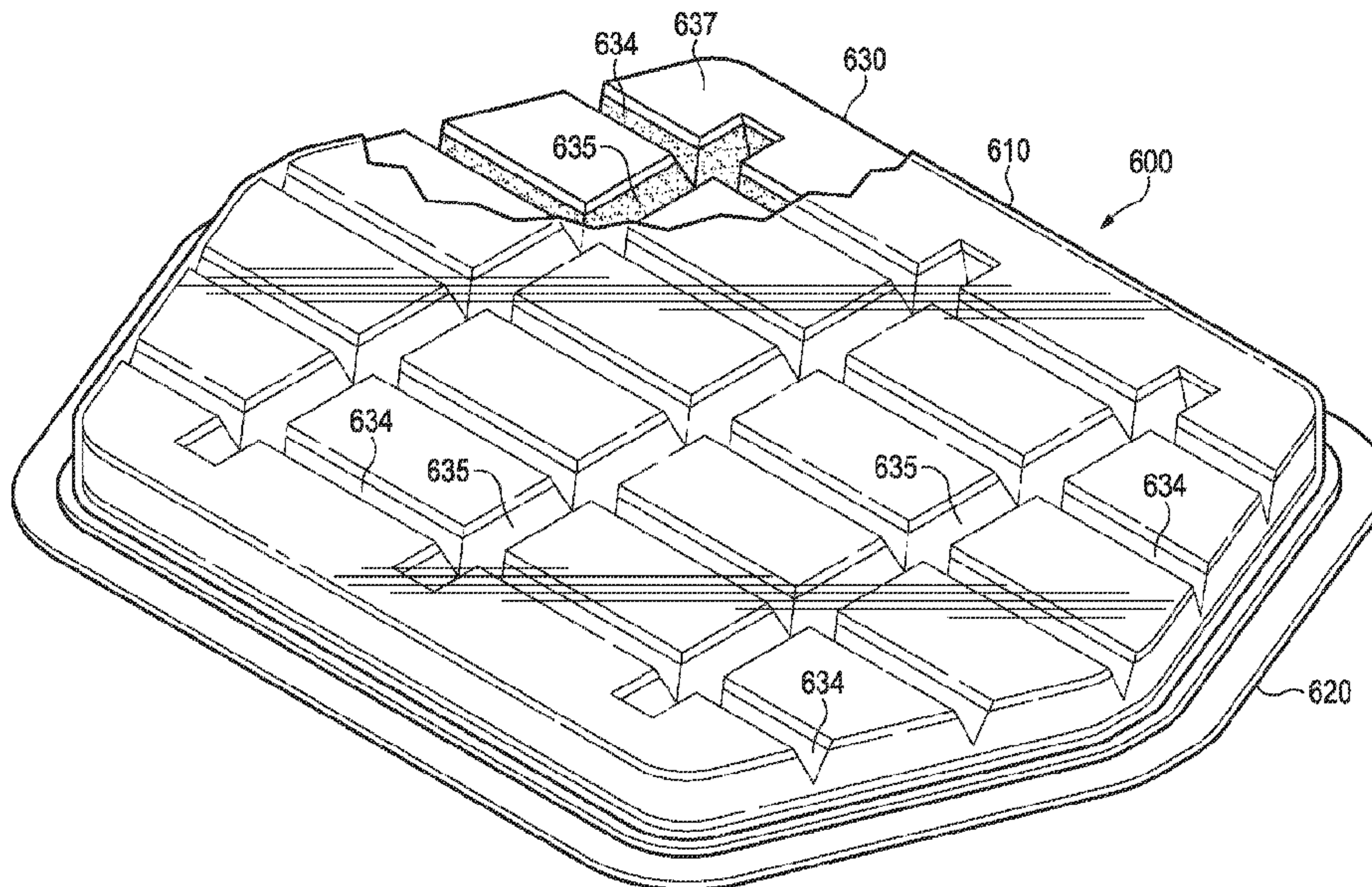




(86) Date de dépôt PCT/PCT Filing Date: 2013/05/30
(87) Date publication PCT/PCT Publication Date: 2013/12/05
(45) Date de délivrance/Issue Date: 2019/09/17
(85) Entrée phase nationale/National Entry: 2014/10/31
(86) N° demande PCT/PCT Application No.: US 2013/043225
(87) N° publication PCT/PCT Publication No.: 2013/181316
(30) Priorité/Priority: 2012/05/31 (US13/485,739)

(51) Cl.Int./Int.Cl. *A41D 13/015* (2006.01),
A41D 13/05 (2006.01)
(72) Inventeur/Inventor:
TURNER, DAVID, US
(73) Propriétaire/Owner:
NIKE INNOVATE C.V., US
(74) Agent: SMART & BIGGAR

(54) Titre : VETEMENTS COMPORTANT DES ELEMENTS DE REMBOURRAGE
(54) Title: ARTICLES OF APPAREL INCORPORATING CUSHIONING ELEMENTS



(57) **Abrégé/Abstract:**

Cushioning elements for apparel may include a pair of material layers and a pad component that is located between and secured to the material layers. At least one of the material layers is formed from an at least partially transparent material. The pad component includes a polymer foam material that defines at least one of a groove and a void, and the pad component includes a surface that includes a bonding agent that joins the pad component to the first material layer. The polymer foam material has a first color and the bonding agent has a second color that is different than the first color.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau



(10) International Publication Number

WO 2013/181316 A3

(43) International Publication Date
5 December 2013 (05.12.2013)

(51) International Patent Classification:

A41D 13/015 (2006.01) *A41D 13/05* (2006.01)

(21) International Application Number:

PCT/US2013/043225

(22) International Filing Date:

30 May 2013 (30.05.2013)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

13/485,739 31 May 2012 (31.05.2012) US

(71) **Applicant** (for all designated States except US): **NIKE INTERNATIONAL LTD.**; One Bowerman Drive, Beaverton, OR 97005-6453 (US).

(72) **Inventor; and**

(71) **Applicant** (for US only): **TURNER, David** [CA/US]; C/o Nike, Inc., One Bowerman Drive, Beaverton, OR 97005-6453 (US).

(74) **Agents**: **MAHALINGAPPA, Jennifer, R.** et al.; Plumsea Law Group, LLC, 10411 Motor City Drive, Suite 320, Bethesda, MD 20817 (US).

(81) **Designated States** (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,

BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

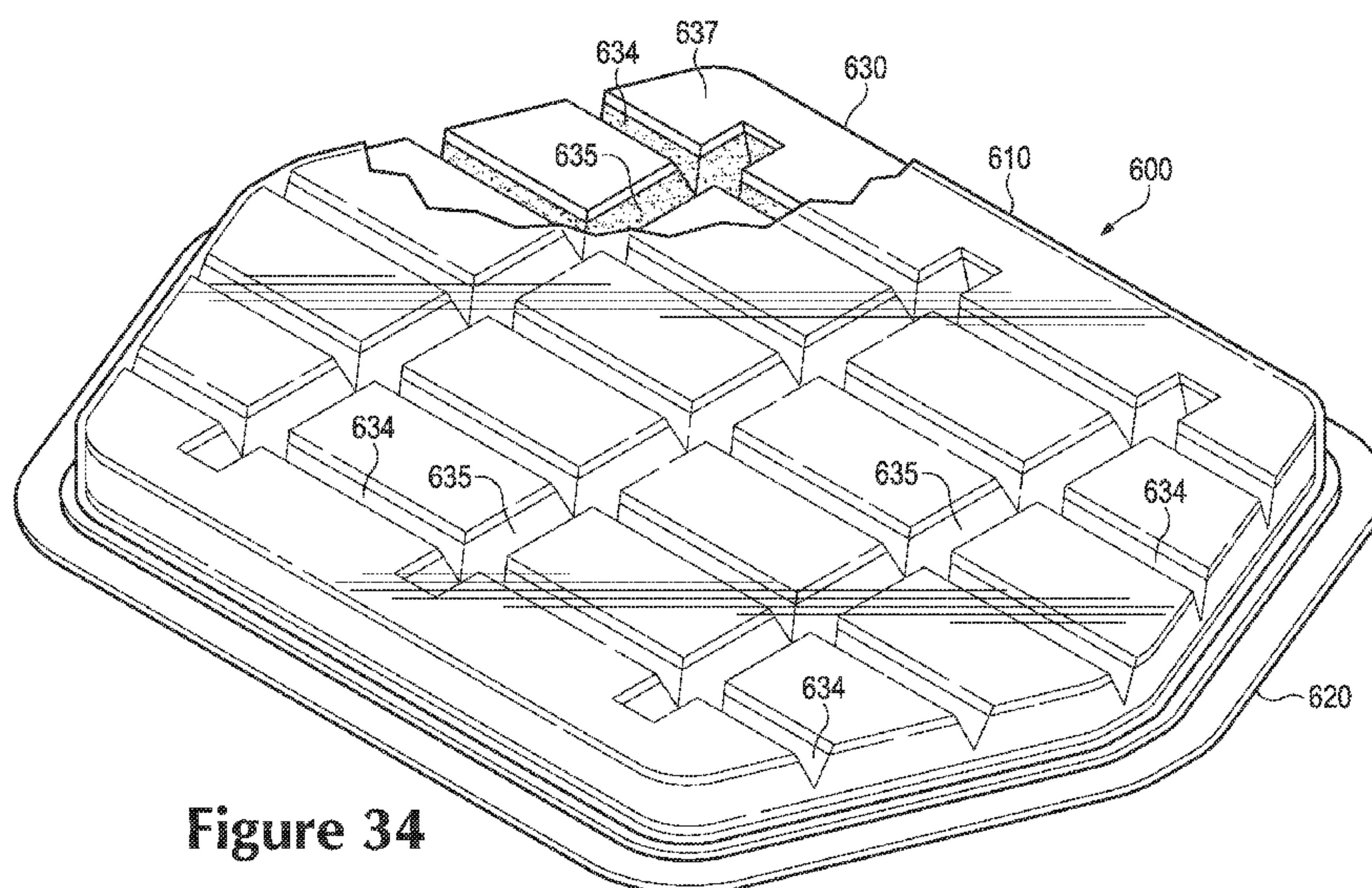
Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

(88) **Date of publication of the international search report:**

18 September 2014

(54) **Title**: ARTICLES OF APPAREL INCORPORATING CUSHIONING ELEMENTS

**Figure 34**

(57) **Abstract**: Cushioning elements for apparel may include a pair of material layers and a pad component that is located between and secured to the material layers. At least one of the material layers is formed from an at least partially transparent material. The pad component includes a polymer foam material that defines at least one of a groove and a void, and the pad component includes a surface that includes a bonding agent that joins the pad component to the first material layer. The polymer foam material has a first color and the bonding agent has a second color that is different than the first color.

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ARTICLES OF APPAREL INCORPORATING CUSHIONING ELEMENTS

CROSS-REFERENCE TO RELATED APPLICATIONS

[01]

BACKGROUND

[02] Materials or elements that impart padding, cushioning, or otherwise attenuate impact forces are commonly incorporated into a variety of products. Athletic apparel, for example, often incorporates cushioning elements that protect the wearer from contact with other athletes, equipment, or the ground. More specifically, pads used in American football and hockey incorporate cushioning elements that provide impact protection to various parts of a wearer. Helmets utilized during American football, hockey, bicycling, skiing, snowboarding, and skateboarding incorporate cushioning elements that provide head protection during falls or crashes. Similarly, gloves utilized in soccer (e.g., by goalies) and hockey incorporate cushioning elements that provide protection to the hands of a wearer. Cushioning elements may also be incorporated into bicycling shorts. Apparel that is utilized for generally non-athletic purposes may also incorporate cushioning elements, such as apparel that is worn for motorcycle riding and knee protectors for gardening or construction work.

SUMMARY

[03] Various cushioning elements that may be utilized in apparel and a variety of other products are disclosed below. In general, the cushioning elements include a pair of material layers and a pad component that is located between and secured to the material layers. At least one of the material layers is formed from an at least partially transparent material. The pad component includes a polymer foam material that defines at least one of a groove and a void, and the pad component includes a surface that includes a bonding agent that joins the pad component to the first material layer. The polymer foam material has a first color and the bonding agent has a second color that is different than the first color.

[03a] In some embodiments there is provided an article of apparel incorporating at least one cushioning element for attenuating impact forces, the cushioning element comprising: a first material layer and a second material layer, the first material

layer being formed from an at least partially transparent material; and a pad component located between the first material layer and the second material layer, the pad component including a first surface and an opposite second surface, the first surface facing the first material layer, and the second surface facing the second material layer, and the pad component including a polymer foam material that defines (a) a plurality of elongate grooves that extend from the first surface toward the second surface and (b) a plurality of elongate voids that extend through the pad component and from the first surface to the second surface, the first surface including a bonding agent comprising a colored thermoplastic polymer sheet that joins the pad component to the first material layer, the polymer foam material having a first color and the colored thermoplastic polymer sheet having a second color that is different than the first color.

[03b] In some embodiments there is provided an article of apparel incorporating at least one cushioning element for attenuating impact forces, the cushioning element comprising: a first material layer and a second material layer, the first material layer being formed from an at least partially transparent material; and a pad component located between the first material layer and the second material layer, the pad component including a first surface and an opposite second surface, the first surface having a first color and being joined with the first material layer, and the second surface being joined with the second material layer, and the pad component including at least one of (a) a plurality of elongate, slope-sided grooves that extend from the first surface toward the second surface and that have sloping surfaces that angle towards one another as the sloping surfaces extend towards the second surface and (b) a plurality of elongate voids that extend through the pad component and from the first surface to the second surface, the sloping surfaces exposing an interior of the pad component having a second color that is different than the first color.

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

FIGURE DESCRIPTIONS

- [05] The foregoing Summary and the following Detailed Description will be better understood when read in conjunction with the accompanying figures.
- [06] Figure 1 is a front elevational view of an individual wearing an article of apparel.
- [07] Figure 2 is a front elevational view of the article of apparel.
- [08] Figures 3 and 4 are side elevational views of the article of apparel.
- [09] Figure 5 is a rear elevational view of the article of apparel.
- [10] Figure 6 is a perspective view of a first cushioning element.
- [11] Figure 7 is an exploded perspective view of the first cushioning element.
- [12] Figure 8 is a top plan view of the first cushioning element.
- [13] Figures 9A-9C are cross-sectional views of the first cushioning element, as defined by section lines 9A-9C in Figure 8.
- [14] Figure 10A is a cross-sectional view corresponding with Figure 9A and depicting the first cushioning element in a flexed configuration.
- [15] Figure 10B is a cross-sectional view corresponding with Figure 9A and depicting the first cushioning element in a stretched configuration.
- [16] Figure 10C is a cross-sectional view corresponding with Figure 9C and depicting breathability of the first cushioning element.
- [17] Figure 11 is a perspective view of portions of a manufacturing apparatus utilized in a manufacturing process for the first cushioning element.
- [18] Figures 12A-12D are schematic perspective views of the manufacturing process.

- [19] Figures 13A-13D are schematic cross-sectional views of the manufacturing process, as respectively defined by section lines 13A-13D in Figures 12A-12D.
- [20] Figures 14A-14K are top plan views corresponding with Figure 8 and depicting further configurations of the first cushioning element.
- [21] Figures 15A-15J are perspective views depicting further configurations of a first pad component from the first cushioning element.
- [22] Figures 16A-16R are cross-sectional views corresponding with Figure 9A and depicting further configurations of the first cushioning element.
- [23] Figures 17A-17G are elevational views of further articles of apparel incorporating the cushioning element.
- [24] Figure 18 is a front elevational view of another configuration of the article of apparel.
- [25] Figure 19 is a perspective view of a second cushioning element.
- [26] Figure 20 is an exploded perspective view of the second cushioning element.
- [27] Figure 21 is a top plan view of the second cushioning element.
- [28] Figure 22 is a top plan view of a second pad component from the second cushioning element.
- [29] Figures 23A-23D are cross-sectional views of the second pad component, as defined by section lines 23A-23D in Figure 22.
- [30] Figures 24A is a top plan view of the second pad component in a stretched configuration.
- [31] Figures 24B is a top plan view of the second pad component in a compressed configuration.
- [32] Figures 25A-25H are top plan views corresponding with Figure 22 and depicting further configurations of the second pad component.

- [33] Figure 26 is a top plan view corresponding with Figure 22 and depicting another configuration of the second pad component.
- [34] Figures 27A-27E are cross-sectional views, as defined by section lines 27A-27E in Figure 26.
- [35] Figure 28 is a top plan view corresponding with Figure 22 and depicting another configuration of the second pad component.
- [36] Figures 29A-29D are cross-sectional views, as defined by section lines 29A-29D in Figure 28.
- [37] Figures 30A-30D are cross-sectional views corresponding with Figure 29D and depicting further configurations of the second pad component.
- [38] Figures 31A-31E are cross-sectional views corresponding with Figure 23D and depicting further configurations of the second pad component.
- [39] Figures 32 and 33 are top plan views corresponding with Figure 22 and depicting further configurations of the second pad component.
- [40] Figure 34 is a perspective view of a third cushioning element.
- [41] Figure 35 is an exploded perspective view of the third cushioning element.
- [42] Figure 36 is a top plan view of the third cushioning element.
- [43] Figures 37A and 37B are cross-sectional views of the third cushioning element, as defined by section lines 37A and 37B in Figure 36.
- [44] Figure 38 is a top plan view depicting another configuration of the third cushioning element.

DETAILED DESCRIPTION

- [45]** The following discussion and accompanying figures disclose various configurations of cushioning elements that may be incorporated into a variety of products, including articles of apparel, such as shorts, pants, shirts, wraps, footwear, gloves, and helmets.
- [46]** Apparel Configuration
- [47]** With reference to Figure 1, a wearer or individual 10 is depicted as wearing an article of apparel 100 with the general configuration of a pair of shorts. Although apparel 100 may be worn under other articles of apparel, apparel 100 may be worn alone, may be exposed, or may be worn over other articles of apparel. Apparel 100 may also be worn in combination with other pieces of equipment (e.g., athletic or protective equipment). Although apparel 100 may be loose-fitting, apparel 100 is depicted as having a relatively tight fit of a compression garment. Accordingly, the configuration of apparel 100 and the manner in which apparel 100 is worn by individual 10 may vary significantly.
- [48]** Apparel 100 is depicted individually in Figures 2-5 as including a pelvic region 101 and a pair of leg regions 102 that extend outward from pelvic region 101. Pelvic region 101 corresponds with a pelvic area of individual 10 and covers at least a portion of the pelvic area when worn. An upper area of pelvic region 101 defines a waist opening 103 that extends around a waist of individual 10 when apparel 100 is worn. Leg regions 102 correspond with a right leg and a left leg of individual 10 and cover at least a portion of the right leg and the left leg when worn. Lower areas of leg regions 102 each define a thigh opening 104 that extends around a thigh of individual 10 when apparel 100 is worn. Additionally, apparel 100 includes an exterior surface 105 that faces away from individual 10 when apparel 100 is worn, and apparel 100 includes an opposite interior surface 106 that faces toward individual 10 and may contact individual 10 when apparel 100 is worn.
- [49]** A plurality of cushioning elements 200 are incorporated into various areas of apparel 100 to impart padding, cushioning, or otherwise attenuate impact forces. When apparel 100 is worn during athletic activities, for example,

cushioning elements 200 may protect individual 10 from contact with other athletes, equipment, or the ground. With regard to apparel 100, cushioning elements 200 are located in both of pelvic region 101 and leg regions 102 and are positioned, more specifically, to protect the hips, thighs, and tailbone of individual 10. As described in greater detail below, cushioning elements 200 may be incorporated into a variety of different articles of apparel, and cushioning elements 200 may be positioned in various areas of the articles of apparel to protect specific portions (e.g., muscles, bones, joints, impact areas) of individual 10. Additionally, the shapes, sizes, and other properties of cushioning elements 200, as well as the materials and components utilized in cushioning elements 200, may vary significantly to provide a particular level of protection to the specific portions of individual 10.

[50] Cushioning Element Configuration

[51] An example configuration for cushioning element 200 is depicted in Figures 6-9B as having a generally elongate shape with pointed end areas, which is the shape depicted as being incorporated into apparel 100. Cushioning element 200 includes a first material layer 210, a second material layer 220, and a pad component 230. First material layer 210 and second material layer 220 cooperatively form an outer surface or covering for cushioning element 200. That is, first material layer 210 and second material layer 220 cooperatively form a pocket or void, in which pad component 230 is located. Whereas second material layer 220 is depicted as having a generally planar configuration, first material layer 210 extends over pad component 230 and also along sides of pad component 230 to join with second material layer 220 (e.g., through stitching, adhesive bonding, or thermal bonding). Although cushioning element 200 may be incorporated into apparel 100 in a variety of ways, first material layer 210 may be positioned exterior of second material element 220, such that cushioning element 200 protrudes outward from apparel 100. Alternately, second material layer 220 may be positioned exterior of first material element 210, such that cushioning element 200 protrudes inwardly.

- [52]** Whereas first material layer 210 has a shape that covers pad component 230, second material layer 220 may have a larger size that forms additional portions of apparel 100. For example, second material layer 220 may extend into both pelvic region 101 and one of leg regions 102. That is, second material layer 220 may form one surface of cushioning element 200 and extend to other areas apparel 100 to form a covering for individual 10. In this configuration, first material layer 210 forms a portion of exterior surface 105, whereas second material layer 220 forms a portion of both exterior surface 105 and interior surface 106. More particularly, a portion of second material layer 220 that is secured to pad component 230 is located inward of first material layer 210 and forms a portion of interior surface 106. Another portion of second material layer 220 that is spaced from pad component 230 forms a portion of exterior surface 105, as well as interior surface 106. As such, second material layer 220 forms both a portion of a covering for pad component 230 and other portions of apparel 100.
- [53]** A variety of materials may be utilized for first material layer 210 and second material layer 220, including various textiles, polymer sheets, leather, or synthetic leather, for example. Combinations of these materials (e.g., a polymer sheet bonded to a textile) may also be utilized for each of material layers 210 and 220. Although material layers 210 and 220 may be formed from the same material, each of material layers 210 and 220 may also be formed from different materials. With regard to textiles, material layers 210 and 220 may be formed from knitted, woven, non-woven, spacer, or mesh textile components that include rayon, nylon, polyester, polyacrylic, elastane, cotton, wool, or silk, for example. Moreover, the textiles may be non-stretch, may exhibit stretch in one direction, or may exhibit multi-directional stretch. Accordingly, a variety of materials are suitable for first material layer 210 and second material layer 220.
- [54]** Pad component 230 is located between and secured to each of material layers 210 and 220. More particularly, pad component 230 has a first surface 231 secured to first material layer 210, an opposite second surface 232 secured to second material layer 220, and a side surface 233 that extends

between surfaces 231 and 232. First surface 231 defines a plurality of first grooves 234 that extend throughout a length of pad component 230 and toward second surface 232. Similarly, second surface 232 defines a plurality of second grooves 235 that extend throughout the length of pad component 230 and toward first surface 231. First grooves 234 are aligned with second grooves 235. As utilized herein, "aligned" is defined as extending in a common direction and includes (a) parallel configurations for grooves 234 and 235 and (b) non-parallel configurations for grooves 234 and 235 that are offset between zero and thirty degrees. As such, when grooves 234 and 235 are aligned, they are generally oriented extend in the same direction. Additionally, grooves 234 and 235 are offset from each other. That is, first grooves 234 are located in areas of pad component 230 that are between areas where second grooves 235 are located. Moreover, each of grooves 234 and 235 are depicted as having a triangular, V-shaped, angled, or pointed configuration. Although pad component 230 is secured to material layers 210 and 220, one or both of surfaces 231 and 232 may also be unsecured to material layers 210 and 220. In either configuration, surfaces 231 and 232 generally face toward material layers 210 and 220.

- [55] Although features of pad component 230 and grooves 234 and 235 may vary considerably, as discussed in greater detail below, some examples of suitable configurations are discussed here. For example, pad component 230 may have a thickness (i.e., distance between surfaces 231 and 232) of ten millimeters. Given this thickness, grooves 234 and 235 may have a width of five millimeters and a depth of five millimeters. As such, grooves 234 and 235 may extend through approximately fifty percent of a thickness of pad component 230. Moreover, grooves 234 and 235 may be spaced by twenty millimeters. An advantage to the various dimensions discussed above relates to imparting a suitable degree flex, stretch, and breathability to cushioning element 200, as discussed below. These dimensions and percentages, however, are intended to merely be examples, and the dimensions and percentages may vary considerably from the specific numbers identified above.

- [56]** A variety of materials may be utilized for pad component 230, including various polymer foam materials that return to an original shape after being compressed. Examples of suitable polymer foam materials for pad component 230 include polyurethane, ethylvinylacetate, polyester, polypropylene, and polyethylene foams. Moreover, both thermoplastic and thermoset polymer foam materials may be utilized. In some configurations of cushioning element 200, pad component 230 may be formed from a polymer foam material with a varying density, or solid polymer or rubber materials may be utilized. Fluid-filled chambers may also be utilized as pad component 230. Also, different pad component 230 may be formed from different materials, or may be formed from similar materials with different densities. As discussed in greater detail below, the polymer foam materials forming pad component 230 attenuate impact forces to provide cushioning or protection. By selecting thicknesses, materials, and densities for each of the various pad component 230, the degree of impact force attenuation may be varied throughout apparel 100 to impart a desired degree of cushioning or protection.
- [57]** The compressible polymer foam materials forming pad component 230 attenuate impact forces that compress or otherwise contact cushioning element 200. When incorporated into apparel 100 or another article of apparel, for example, the polymer foam materials of pad component 230 may compress to protect a wearer from contact with other athletes, equipment, or the ground. Accordingly, cushioning element 200 may be utilized to provide cushioning or protection to areas of individual 10 or other wearers that are covered by cushioning element 200.
- [58]** In addition to attenuating impact forces, cushioning element 200 has an advantage of simultaneously providing one or more of flex, stretch, breathability, relatively low overall mass, and launderability. Referring to Figure 10A, cushioning element 200 is depicted as being flexed. In this configuration, first grooves 234 effectively expand and second grooves 235 effectively collapse to impart flexibility. Referring to Figure 10B, cushioning element 200 is depicted as being stretched by a force 20. In this configuration, the offset structure of grooves 234 and 235 permits pad

component 230 to flatten or otherwise elongate due to the effects of force 20. An advantage to flex and stretch is that cushioning element 200 may better conform with contours of individual 10, and cushioning element 200 may expand, collapse, flatten, and elongate to facilitate movements of individual 10, while still conforming with the contours of individual 10 during the movements. Additionally, individual 10 may generate excess heat and perspire when wearing apparel 100 and engaging in athletic activities. Referring to Figure 10C, the breathability of cushioning element 200 is depicted by various paths 30, along which heat and moisture may pass to exit cushioning element 200. The heat and moisture from individual 10 may, therefore, (a) pass through second material layer 220, (b) enter one of second grooves 235, (c) move to end areas of second groove 235, and (d) pass through first material layer 210, thereby exiting apparel 100. Furthermore, the materials and structure discussed above for cushioning element 200 (a) imparts a relatively low overall mass that does not add significant weight to individual 10 during the athletic activities and (b) permits laundering without significant shrinkage or warping, even when temperatures associated with commercial laundering processes are utilized. Accordingly, cushioning element 200 may simultaneously provide impact force attenuation, flex, stretch, breathability, relatively low overall mass, and launderability.

[59] Manufacturing Process

[60] A variety of techniques may be utilized to manufacture cushioning element 200. With reference to Figure 11, a manufacturing apparatus 300 is disclosed as including a press 310 and a sewing machine 320. Other elements, such as a mold, router, die cutter, or laser may also be utilized, but are not depicted here. A variety of other manufacturing apparatuses that operate in a similar manner may also be utilized. Accordingly, manufacturing apparatus 300 is only intended to provide an example of a manufacturing apparatus for the production of cushioning element 200.

[61] Initially, the various components of cushioning element 200 are cut, shaped, or otherwise prepared. For example, material layers 210 and 220 may be cut to a particular shape using die cutting, laser cutting, or hand cutting

processes. Whereas first material layer 210 has a shape that covers pad component 230 and extends alongside surface 233, second material layer 220 may have a larger size that forms additional portions of apparel 100. For example, second material layer 220 may extend into both pelvic region 101 and one of leg regions 102. That is, second material layer 220 may form one surface of cushioning element 200 and extend to other areas apparel 100 to form a covering for individual 10. Various processes may also be utilized to form pad component 230. For example, polymer resin with a blowing agent may be located in a mold having the shape of pad component 230. An advantage to this process is that a single process may be used to form the polymer foam material of pad component 230, as well as the various grooves 234 and 235. As another example, a preformed layer of polymer foam may be obtained, and a router may be used to form grooves 234 and 235. In other processes, grooves 234 and 235 may be formed from a heated element that presses into a preformed layer of polymer foam, or a computer-controlled machine tool may be utilized. As yet further examples, a three-dimensional printer may be utilized to form pad component 230, or a polymer foam element having grooves 234 and 235 may be extruded and then cut to the shape of pad component 230.

- [62]** Once the various components of cushioning element 200 are cut, shaped, or otherwise prepared, the components may be placed between two platens 311 and 312 of press 310, as depicted in Figures 12A and 13A. More particularly, first material layer 210 may be located adjacent to platen 311, second material layer 220 may be located adjacent to platen 312, and pad component 230 may be located between layers 210 and 220. Following proper positioning, platens 311 and 312 close upon and compress first material layer 210, second material layer 220, and pad component 230, as depicted in Figures 12B and 13B. More particularly, platen 311 compresses first material layer 210 against first surface 231 of pad component 230, and platen 312 compresses second material layer 220 against second surface 232 of pad component 230.

[63] Platens 311 and 312 effectively compress pad component 230 between material layers 210 and 220 to ensure bonding. As an example, an adhesive may be utilized to bond pad component 230 to each of material layers 210 and 220. At prior stages of the manufacturing process, an adhesive may be applied to either (a) areas of material layers 210 and 220 that are intended to bond with pad components 230 or (b) surfaces 231 and 232 of pad component 230. Although the adhesive may be applied to material layers 210 and 220, an advantage of applying the adhesive to surfaces 231 and 232 is that the adhesive is absent from areas of material layers 210 and 220 that are not intended to bond with pad component 230. As another example, heat may be utilized to bond pad component 230 to each of material layers 210 and 220. In configurations where pad component 230 is formed from a thermoplastic polymer foam material, heating and melting of pad component 230 at surfaces 231 and 232 may be utilized to bond pad component 230 to each of material layers 210 and 220. Similarly, material layers 210 and 220 may also incorporate a thermoplastic polymer material, or a thermoplastic bonding agent or thermally-activated adhesive may be utilized. In order to elevate the temperatures, various radiant heaters, radio frequency emitters, or other devices may be utilized. Alternately, press 310 may be heated such that contact with platens 311 and 312 raises the temperature of pad component 230 to a level that facilitates bonding.

[64] One consideration at this stage of the manufacturing process relates to the method by which an adhesive, thermoplastic polymer material, or a thermoplastic bonding agent is applied to the components of cushioning element 200. As noted above, an advantage of applying an adhesive to surfaces 231 and 232 is that the adhesive is absent from areas of material layers 210 and 220 that are not intended to bond with pad component 230. A similar advantage applies to a thermoplastic polymer material or thermoplastic bonding agent. Moreover, applying the adhesive, thermoplastic polymer material, or thermoplastic bonding agent to surfaces 231 and 232 prior to the formation of grooves 234 and 235 may ensure that the bonding materials are absent from grooves 234 and 235. For example, when thermoplastic polymer sheets are utilized as the bonding material, the thermoplastic polymer sheets

may be bonded or secured to opposite sides of a polymer foam member (i.e., the polymer foam member that forms pad component 230). Then, grooves 234 and 235 may be formed using a router or other process, which effectively removes portions of the thermoplastic polymer sheets located at grooves 234 and 235. As such, the thermoplastic polymer sheets are absent from grooves 234 and 235 and effectively limited to the areas of surfaces 231 and 232 that bond with layers 210 and 220. Accordingly, by selecting a particular order for the manner in which components of cushioning element 200 are applied, excess materials that may form unintended bonds or detract from the aesthetic properties of cushioning element 200 may be avoided.

[65] Following compression and bonding, platens 311 and 312 separate to expose the components of cushioning element 200, as depicted in Figures 12C and 13C. At this stage of the manufacturing process, first material layer 210 is unsecured to second material layer 220. Additional stitching, adhesive, or thermal bonding steps may now be utilized to join material layers 210 and 220 around the periphery of pad components 230. As an example, sewing machine 320 may be utilized to stitch material layers 210 and 220 together, as depicted in Figures 12D and 13D, thereby substantially completing the manufacture of cushioning element 200.

[66] Further Cushioning Element Configurations

[67] Aspects of cushioning element 200 may vary, depending upon the intended use for cushioning element 200 and the product in which cushioning element 200 is incorporated. Moreover, changes to the dimensions, shapes, and materials utilized within cushioning element 200 may vary the overall properties of cushioning element 200. That is, by changing the dimensions, shapes, and materials utilized within cushioning element 200, the compressibility, impact force attenuation, flex, stretch, breathability, and overall mass of cushioning element 200 may be tailored to specific purposes or products. A plurality of variations for cushioning element 200 are discussed below. Any of these variations, as well as combinations of these variations, may be utilized to tailor the properties of cushioning element 200 to

an intended use. Moreover, any of these variations may be manufactured through the process or variations of the process discussed above.

- [68]** As discussed above, cushioning component 200 may have a generally elongate shape with pointed end areas. The overall shape of cushioning element 200 may, however, vary to include a variety of other shapes. Referring to Figure 14A, cushioning element 200 exhibits a generally rectangular shape. In further configurations, cushioning element 200 may have a round, triangular, hexagonal, or H-shaped structure, as respectively depicted in Figures 14B-14E. Although any of these shapes may be utilized in apparel 100, various other shapes may also be utilized. As examples, Figure 14F depicts a configuration of cushioning element 200 with a shape suitable for a hip pad, Figure 14G depicts a configuration of cushioning element 200 with a shape suitable for a thigh pad, and Figure 14H depicts a configuration of cushioning element 200 with a shape suitable for a tailbone pad. A configuration for cushioning element 200 that has a shape suitable for an elbow pad (e.g., for a shirt, jacket, or arm sleeve) is depicted in Figure 14I.
- [69]** Various aspects relating to first material layer 210 and second material layer 220 may also vary significantly. As discussed above, material layers 210 and 220 may be formed from various textiles, polymer sheets, leather, synthetic leather, or combinations of materials, for example. Moreover, breathability may be enhanced when the materials are air-permeable. In general, textiles are permeable to both heat and moisture. Polymer sheets, leather, synthetic leather, or combinations of materials, however, may not exhibit significant permeability. As depicted in Figure 14J, various perforations, holes, or apertures may be formed in one or both of material layers 210 and 220 to enhance breathability. In further configurations, as depicted in Figure 14K, first material layer 210 may be entirely absent from cushioning element 200.
- [70]** Aspects relating to pad component 230 may also vary to tailor cushioning element 200 to an intended use or enhance the properties of cushioning element 200. As an example, the configuration of grooves 234 and 235 may vary. Referring to Figures 15A and 15B, the width of grooves 234 and 235 and the spacing between grooves 234 and 235 are both increased and

decreased from the configuration discussed above. Referring to Figure 15C, grooves 234 and 235 extend across the width of pad component 230, rather than extending across the length. In order to impart flex and stretch in multiple directions, grooves 234 and 235 may have a crossed configuration extending across both the length and width of pad component 230, as depicted in Figure 15D. Although grooves 234 and 235 may be linear, wavy or non-linear configurations are depicted in Figures 15E and 15F. In another configuration, pad component 230 may be segmented or otherwise formed from two or more separate elements. Referring to Figure 15G, for example, pad component 230 includes three spaced sections, which may enhance the flex and breathability of cushioning element 200.

[71] Although grooves 234 and 235 may extend entirely across pad component 230, grooves 234 and 235 may also extend only partially across pad component 230. Referring to Figure 15H, for example, first grooves 234 extend across a majority of the length of pad component 230, but are spaced from peripheral areas of pad component 230. Second grooves 235 may have a similar configuration. In Figure 15I, grooves 234 and 235 are located in one region of pad component 230, but are absent from another region of pad component 230. Grooves 234 and 235 may also extend only partially across pad component 230 from opposite sides of pad component 230, as depicted in Figure 15J. Accordingly, grooves 234 and 235 may have various configurations that extend at least partially across pad component 230.

[72] Various aspects relating to the relative size and locations of grooves 234 and 235 may also vary significantly. Referring to Figure 16A, for example, grooves 234 and 235 are aligned across the thickness of pad component 230, rather than being offset. Figure 16B depicts a configuration wherein the spacing of grooves 234 and 235 varies across the width of pad component 230, and Figure 16C depicts a configuration wherein the depth of grooves 234 and 235 varies across the width of pad component 230. Although the depth of grooves 234 and 235 may extend through about fifty percent of the thickness of pad components 230, the depth of grooves 234 and 235 may range from five percent to ninety-five percent of the thickness of pad

component 230 in different configurations. In some configurations, first grooves 234 may be absent from pad component 230, as depicted in Figure 16D, but second grooves 235 may also be absent.

[73] In many of the configurations discussed above, grooves 234 and 235 are depicted as having a triangular, angled, or pointed configuration. Referring to Figure 16E, grooves 234 and 235 have rounded or semi-circular shapes. Grooves 234 and 235 may also be squared, elongate and rectangular, or dovetailed (i.e., increasing in width as depth increases), as depicted in Figures 16F-16H. Various different shapes for grooves 234 and 235 may also be utilized in combination, as depicted in Figure 16I.

[74] Various additional features may be incorporated into pad component 230. Referring to Figure 16J, various apertures 236 extend through pad component 230, which may enhance the breathability of cushioning element 200. In some configurations, a greater thickness may be desired, as in Figure 16K, or a lesser thickness may be desired, as in Figure 16L. Pad component 230 may also have a layered configuration, as depicted in Figure 16M. As an example, the layers may be different types or polymer foam or densities of polymer foam, or the layers may be different materials, such as polymer foam and rubber. Although the thicknesses of pad component 230 may be constant, pad component 230 may also have varying or tapered thicknesses, as depicted in Figure 16N. In some configurations of cushioning element 200, a central area of pad component 230 may have greater thickness than a peripheral area of pad component 230, as depicted in Figure 16O. Additionally, pad component 230 may have a rounded or contoured shape, as depicted in Figure 16P.

[75] In each of the configurations discussed above, material layers 210 and 220 were absent from grooves 234 and 235. That is, material layers 210 and 220 are not depicted as extending into grooves 234 and 235. Referring to Figure 16Q, however, material layers 210 and 220 extend into grooves 234 and 235 and are secured to surfaces within grooves 234 and 235. In addition to enhancing flex, stretch, and breathability, this configuration may also present a unique or appealing aesthetic to apparel 100.

- [76] In the manufacturing process discussion above, it was noted that various bonding agents (e.g., adhesives, thermoplastic polymer sheets) may be utilized to bond layers 210 and 220 to pad component 230. Moreover, various methods may be employed to ensure that the bonding agents are limited to the areas of surfaces 231 and 232 that bond with layers 210 and 220. Referring to Figure 16R, a bonding agent 237 is located between pad component 230 and layers 210 and 220. Moreover, bonding agent 237 is limited to the areas of surfaces 231 and 232 that bond with layers 210 and 220, thereby being absent from side surface 233 and the area within grooves 234 and 235.
- [77] Based upon the above discussion, various properties of cushioning element 200 may vary. Depending upon the specific type of apparel or location in the apparel, the properties may impart different degrees of impact force attenuation, flex, stretch, breathability, or other characteristics. As such, the variations discussed above may be utilized individually or in combination to impart particular characteristics to cushioning element 200.
- [78] Further Apparel Configurations
- [79] Apparel 100 is depicted as having the general configuration of a pair of shorts. Another shorts configuration is depicted in Figure 17A and includes the shapes of cushioning elements depicted in Figures 14F and 14G. In addition to shorts, the concepts discussed in relation to apparel 100 may be applied to other types of apparel. Figure 17B, for example, depicts a pair of pants 401 that includes various cushioning elements 200. Referring to Figure 17C, a shirt 402 is depicted as including various cushioning elements 200 in locations that correspond with the sides, arms, and shoulders of a wearer. Although apparel 402 is depicted as a long-sleeved shirt, apparel 402 may have the configuration of other shirt-type garments, including short-sleeved shirts, tank tops, undershirts, jackets, and coats, for example.
- [80] Cushioning elements 200 may also be incorporated into apparel that covers other areas of the wearer, such as hats, wraps, footwear, socks, gloves, and helmets, for example. As an example, a wrap 403 with one cushioning

element 200 is depicted in Figure 17D. Wrap 403 has a generally cylindrical configuration that may be placed upon an arm or a leg of a wearer. When, for example, the elbow is sore or injured, cushioning element 200 of wrap 403 may be located over the elbow to assist with protecting the elbow during athletic activities. As another example, a sockliner 404 that incorporates a cushioning element 200 is depicted in Figure 17E. Sockliner 404 may be located within an article of footwear to cushion a lower surface of the foot. Additionally, one or more cushioning elements 200 may be incorporated into a glove 405, as depicted in Figure 17F, to impart protection to a hand of the wearer. One or more cushioning elements 200 may also be incorporated into a helmet 406, as depicted in Figure 17G, to impart protection to a head of the wearer. In addition to attenuating impact forces, cushioning elements 200 in these configurations may also simultaneously provide one or more of flex, stretch, breathability, a relatively low overall mass, and launderability.

[81] Second Cushioning Element Configuration

[82] With reference to Figure 18, a plurality of cushioning elements 500 are incorporated into various areas of apparel 100. In effect, cushioning elements 500 are depicted as replacing the various cushioning elements 200 discussed above. As with cushioning elements 200, cushioning elements 500 impart padding, cushioning, or otherwise attenuate impact forces. When apparel 100 is worn during athletic activities, for example, cushioning elements 500 may protect individual 10 from contact with other athletes, equipment, or the ground. With regard to apparel 100, cushioning elements 500 are located in both of pelvic region 101 and leg regions 102 and are positioned, more specifically, to protect the hips, thighs, and tailbone of individual 10. Although shown with apparel 100, cushioning elements 500 may be incorporated into a variety of different articles of apparel, such as any of pants 401, shirt 402, wrap 403, sockliner 404, glove 405, and helmet 406. Cushioning elements 500 may be positioned in various areas of the articles of apparel to protect specific portions (e.g., muscles, bones, joints, impact areas) of individual 10. Additionally, the shapes, sizes, and other properties of cushioning elements 500, as well as the materials and components utilized in cushioning elements

500, may vary significantly to provide a particular level of protection to the specific portions of individual 10.

[83] An example configuration for cushioning element 500 is depicted in Figures 19-21 as having a generally elongate shape with pointed end areas, which is the shape depicted as being incorporated into apparel 100. As alternatives to this shape, cushioning element 500 may exhibit any of the shapes depicted in Figures 14A-14I, as well as any other practical shape. The primary components of each cushioning element 500 include a first material layer 510, a second material layer 520, and a pad component 530. First material layer 510 and second material layer 520 cooperatively form an outer surface or covering for cushioning element 500. That is, first material layer 510 and second material layer 520 cooperatively form a pocket or void, in which pad component 530 is located. Whereas second material layer 520 is depicted as having a generally planar configuration, first material layer 510 extends over pad component 530 and also along sides of pad component 530 to join with second material layer 520 (e.g., through stitching, adhesive bonding, or thermal bonding). Although cushioning element 500 may be incorporated into apparel 100 in a variety of ways, first material layer 510 may be positioned exterior of second material element 520, such that cushioning element 500 protrudes outward from apparel 100. Alternately, second material layer 520 may be positioned exterior of first material element 510, such that cushioning element 500 protrudes inwardly and toward individual 10.

[84] Whereas first material layer 510 has a shape that covers pad component 530, second material layer 520 may have a larger size that forms additional portions of apparel 100. For example, second material layer 520 may extend into both pelvic region 101 and one of leg regions 102. That is, second material layer 520 may form one surface of cushioning element 500 and extend to other areas apparel 100 to form a covering for individual 10. In this configuration, first material layer 510 forms a portion of exterior surface 105, whereas second material layer 520 forms a portion of both exterior surface 105 and interior surface 106. More particularly, a portion of second material layer 520 that is secured to pad component 530 is located inward of first

material layer 510 and forms a portion of interior surface 106. Another portion of second material layer 520 that is spaced from pad component 530 forms a portion of exterior surface 105, as well as interior surface 106. As such, second material layer 520 forms both a portion of a covering for pad component 530 and other portions of apparel 100.

- [85]** A variety of materials may be utilized for first material layer 510 and second material layer 520, including various textiles, polymer sheets, leather, or synthetic leather, for example. Combinations of these materials (e.g., a polymer sheet bonded to a textile) may also be utilized for each of material layers 510 and 520. Although material layers 510 and 520 may be formed from the same material, each of material layers 510 and 520 may also be formed from different materials. With regard to textiles, material layers 510 and 520 may be formed from knitted, woven, non-woven, spacer, or mesh textile components that include rayon, nylon, polyester, polyacrylic, elastane, cotton, wool, or silk, for example. Moreover, the textiles may be non-stretch, may exhibit stretch in one direction, or may exhibit multi-directional stretch. Accordingly, a variety of materials are suitable for first material layer 510 and second material layer 520.
- [86]** Pad component 530 is depicted individually in Figures 22-23D. When incorporated into cushioning element 500, pad component 530 is located between and secured to each of material layers 510 and 520. More particularly, pad component 530 has a first surface 531 secured to first material layer 510, an opposite second surface 532 secured to second material layer 520, and a side surface 533 that extends between surfaces 531 and 532 and forms a peripheral edge. In other configurations, however, pad component 530 may be unsecured to one or both of material layers 510 and 520.
- [87]** First surface 531 defines a plurality of elongate grooves 534 that extend throughout a length of pad component 530 and toward second surface 532. For purposes of reference in the various figures, grooves 534 are depicted as being stippled (i.e., speckled or dotted) to assist with distinguishing grooves 534 from other features of pad component 530. Although grooves 534 are

depicted as being aligned with each other, having a squared shape, and being formed in first surface 531, grooves 534 may have various other configurations. For example, grooves 534 may be unaligned with each other, grooves 534 may have any practical shape, and grooves 534 may be formed in first surface 531, second surface 532, or both of surfaces 531 and 532. Moreover, grooves 534 may have any of the numerous features and variations discussed above for grooves 234 and 235, and grooves 534 may have any of the configurations for grooves 234 and 235 depicted in Figures 15A-15J and 16A-16J, for example. Accordingly, grooves 534 may have numerous configurations.

[88] In addition to grooves 534, pad component 530 defines various elongate voids 535 that extend through pad component 530 and from first surface 531 to second surface 532. In effect, voids 535 form apertures or holes in pad component 530. Although voids 535 are depicted as being aligned (i.e., extending in a common direction and being either parallel or offset between zero and thirty degrees) with each other and perpendicular to grooves 534, voids 535 may have a variety of other configurations, some of which are discussed below. As depicted, voids 535 have a length that extends across a majority of a width of pad component 530. End areas of voids 535 are, however, generally spaced inward from side surface 533. In configurations where voids 535 extend entirely across pad component 530, voids 535 will effectively subdivide pad component 530 into two or more separate sections, similar to the configuration of pad component 230 depicted in Figure 15G. As such, spacing end areas of voids 535 inward from side surface 533 retains a one-piece configuration for pad component 530. An advantage of the one-piece configuration is that a single element (i.e., the entirety of pad component 530), rather than multiple separate elements, is positioned relative to material layers 510 and 520 during the manufacturing process for cushioning element 500.

[89] A variety of materials may be utilized for pad component 530, including various polymer foam materials that return to an original shape after being compressed. Examples of suitable polymer foam materials for pad

component 530 include polyurethane, ethylvinylacetate, polyester, polypropylene, and polyethylene foams. Moreover, both thermoplastic and thermoset polymer foam materials may be utilized. In some configurations of cushioning element 500, pad component 530 may be formed from a polymer foam material with a varying density, or solid (i.e., substantially non-foamed) polymer or rubber materials may be utilized. Fluid-filled chambers may also be utilized as pad component 530. Also, different pad components 530 may be formed from different materials, or may be formed from similar materials with different densities, degrees of foaming, or other properties.

[90] The compressible polymer foam materials forming pad component 530 attenuate impact forces that compress or otherwise contact cushioning element 500. When incorporated into apparel 100 or another article of apparel, for example, the polymer foam materials of pad component 530 may compress to protect a wearer from contact with other athletes, equipment, or the ground. By selecting specific thicknesses, materials, and densities for each of the various pad component 530, the degree of impact force attenuation may be varied throughout apparel 100 to impart a desired degree of cushioning or protection. Accordingly, cushioning element 500 may be utilized to provide cushioning or protection to areas of individual 10 or other wearers that are covered by cushioning element 500.

[91] In addition to attenuating impact forces, cushioning element 500 has an advantage of simultaneously providing one or more of flex, stretch, compressibility, breathability, relatively low overall mass, and launderability. Given the presence of grooves 534, pad component 530 flexes, stretches, and breathes in the manner shown in Figures 10A-10C. The presence of voids 535 complements these properties. Referring to Figure 24A, for example, force 20 is shown as stretching pad component 530. In this configuration, voids 535 expand in size more than other areas of pad component 530 to impart greater stretch. Referring to Figure 24B, force 20 is shown as compressing pad component 530. In this configuration, voids 535 decrease in size or otherwise compress more than other areas of pad component 530 to impart greater compressibility. This combination of stretch

and compressibility may, for example, enhance the ability of cushioning element 500 to conform with movements of the body of individual 10. That is, as individual 10 performs various actions (e.g., running, jumping, crouching, twisting) cushioning element 500 may stretch and compress, thereby not hindering movements of the body of individual 10. Additionally, voids 535 impart greater breathability to allow heat and moisture to exit cushioning element 500.

[92] A variety of techniques may be utilized to manufacture cushioning element 500, including the general manufacturing process discussed above for cushioning element 200. Additionally, various processes may be utilized to form pad component 530. In one process, polymer resin with a blowing agent may be located in a mold having the shape of pad component 530. An advantage to this process is that a single process may be used to form the polymer foam material of pad component 530, as well as the various grooves 534 and voids 535. In another process, a preformed layer of polymer foam may be obtained, and a router or other cutting device may be used to form grooves 534 and voids 535. For example, a programmable, multi-function fabrication table may be utilized to form both grooves 534 and voids 535, such as an M Series flatbed cutter manufactured by Gerber Scientific Products of Tolland, Connecticut, United States of America. In other processes, grooves 534 and voids 535 may be formed from a heated element that presses into a preformed layer of polymer foam, or a computer-controlled machine tool may be utilized. As yet further examples, a three-dimensional printer may be utilized to form pad component 530.

[93] Further Cushioning Element Configurations

[94] Aspects of cushioning element 500 may vary, depending upon the intended use for cushioning element 500 and the product in which cushioning element 500 is incorporated. Moreover, changes to the dimensions, shapes, and materials utilized within cushioning element 500 may vary the overall properties of cushioning element 500. That is, by changing the dimensions, shapes, and materials utilized within cushioning element 500, the compressibility, impact force attenuation, flex, stretch, compressibility,

breathability, and overall mass of cushioning element 500 may be tailored to specific purposes or products. A plurality of variations for cushioning element 500 are discussed below. Any of these variations, as well as combinations of these variations, may be utilized to tailor the properties of cushioning element 500 to an intended use. Moreover, any of these variations may be manufactured through the process or variations of the process discussed above.

[95] Various aspects relating to first material layer 510 and second material layer 520 may also vary significantly. As discussed above, material layers 510 and 520 may be formed from various textiles, polymer sheets, leather, synthetic leather, or combinations of materials, for example. Moreover, breathability may be enhanced when the materials are air-permeable. In general, textiles are permeable to both heat and moisture. Polymer sheets, leather, synthetic leather, or combinations of materials, however, may not exhibit significant permeability. As with the configuration of cushioning element 200 depicted in Figure 14J, various perforations, holes, or apertures may be formed in one or both of material layers 510 and 520 to enhance breathability. In some configurations, first material layer 510 may be entirely absent from cushioning element 500, similar to Figure 14K.

[96] Aspects relating to pad component 530 may also vary to tailor cushioning element 500 to an intended use or enhance the properties of cushioning element 500. As an example, grooves 534 may have any of the variations for grooves 235 and 235 discussed above. Referring to Figures 25A, various aspects of voids 535 are modified to illustrate variations. More particularly, an individual void 535 may have (a) a lesser length, (b) an arrangement that is aligned with other voids 535, (c) a lesser width, (d) a greater width, (e) a tapered or non-rectangular shape, or (f) a non-linear shape. Regarding length, voids 535 may extend across a majority of a width of pad component 530 to maximize the stretch and compressibility properties shown in Figures 24A and 24B. By altering the length, however, the degree of stretch and compressibility may be varied in cushioning element 500 or specific areas of cushioning element 500. The width of voids 535 may also vary from one

millimeter to twenty millimeters or more. One consideration with width relates to the ability of objects to protrude through voids 535. By forming voids 535 to have a lesser relative width, the probability of an object protruding through or into voids 535 is decreased. Regarding shape, voids 535 may be rectangular, triangular, non-regular or any shape that imparts a desired degree of flex, stretch, compressibility, and breathability. Moreover, the shapes of voids 535 may be varied for aesthetic reasons.

[97] The arrangement of grooves 534 and voids 535 may also vary significantly. Referring to Figure 25B, grooves 534 extend across the width of pad component 530, whereas voids 535 extend through a majority of the length of pad component 530. Although grooves 534 and voids 535 may be arranged to be perpendicular to each other, grooves 534 and voids 535 may also be offset at other angles, as depicted in Figure 25C. Similarly, grooves 534 and voids 535 may also be parallel to or aligned with each other, as depicted in Figure 25D. Although voids 535 may be arranged to be parallel to each other, voids 535 may also be non-parallel. As an example, Figure 25E depicts voids 535 as radiating outward from a common area. In addition, Figure 25F depicts various voids 535 as intersecting each other to form two X-shaped structures. Accordingly, numerous aspects relating to the shape, orientation, and arrangement of grooves 534 and voids 535 may vary considerably.

[98] Another configuration of pad component 530 is depicted in Figure 25G, in which voids 535 form shapes representing the number one and a star. Voids 535 may, therefore, form relatively complex shapes that provide information or fashion indicia. As examples, voids 535 may (a) display an athlete's assigned number, (b) form a team name, (c) represent a trademark or other identifying information for a manufacturer of apparel 100, or (d) show an abstract depiction for aesthetic purposes. As the complexity of the information or indicia increases, however, one consideration relates to segregating separate sections of pad component 530 with voids 535. Referring again to Figure 25G, two separate voids 535 outline the number one, which forms a pair of connecting portions 537 at upper and lower areas of the number one to ensure that a central area of the number one remains connected to a

remainder of pad component 530. The void 535 outlining the star, however, does not form structures similar to connecting portions 537. As a result, a central area of the star is separate from a remainder of pad component 530. During manufacturing, additional steps may be necessary to ensure that the central area of the star remains properly positioned relative to the remainder of pad component 530.

- [99] In each of the various configurations discussed above, both grooves 534 and voids 535 are present in pad component 530. In some configurations, however, grooves 534 may be absent from pad component 530. Referring to Figure 25H, for example, voids 535 extend through various areas of pad component 530 and provide stretch, compressibility, and breathability throughout cushioning element 500 without grooves 534.
- [100] Grooves 534 and voids 535 cross or otherwise intersect each other in many of the prior examples of pad component 530 discussed above. Referring to Figure 26, however, areas of grooves 534 and voids 535 are aligned with each other. Another manner of considering this structure is that grooves 534 and voids 535 are superimposed or otherwise overlay each other. In any event, Figure 26 depicts configurations where (a) grooves 534 extend from the end areas of various voids 535, (b) grooves 534 and voids 535 alternate across pad component 530, (c) voids 535 extend inward from side surface 533 and to end areas of grooves 534, and (d) grooves 534 alternate between being formed in first surface 531 and second surface 532. Any of these various configurations may be utilized to modify the properties or aesthetics of pad component 530, as well as decreasing the probability of an object protruding through or into voids 535. Moreover, forming grooves 534 within areas of voids 535 may enhance the structural integrity of pad component 530.
- [101] Another configuration is depicted in Figures 28 and 29A-29D, wherein pad component 530 includes a beveled edge 536 that extends around pad component 530 and forms an angled transition between surfaces 531 and 533. Although grooves 534 and voids 535 may be absent from the area of beveled edge 536, grooves 534 are depicted as extending through beveled

edge 536 and voids 535 are depicted as extending to beveled edge 536. In other configurations, however, voids 535 may extend into the area of beveled edge 536 or end areas of grooves 534 and voids 535 may be spaced from beveled edge 536. An advantage of forming pad component 530 to include beveled edge 536 relates to the transition between first surface 531 and side surface 533. More particularly, beveled edge 536 forms a smoother or less abrupt transition between cushioning elements 500 and areas of apparel 100 where cushioning elements 500 are absent. As noted above, apparel 100 may be worn under other articles of apparel or may be worn in combination with other pieces of equipment (e.g., athletic or protective equipment). In either of these scenarios, beveled edge 536 may ensure that the apparel or equipment covering cushioning elements 500 smoothly transitions to areas where cushioning elements 500 are absent. In further configurations, as respectively depicted in Figures 30A-30D, beveled edge 536 may (a) extend to second surface 532, rather than side surface 533, (b) exhibit an outwardly-protruding and rounded configuration, (c) exhibit an inwardly-protruding and rounded configuration, or (d) form an indentation in a side of pad component 530. The specific configuration for beveled edge 536 may depend upon whether apparel 100 is intended to be worn over or under other articles of apparel or equipment. Moreover, a configuration similar to Figure 30D may allow equipment to interface and effectively join with cushioning element 500. That is, a portion of the equipment may extend into the indented area formed by beveled edge 536.

[102] A variety of other aspects relating to pad component 530 may also vary to modify the properties or aesthetics of cushioning element 500. Referring to Figure 31A, voids 535 are depicted as having various example configurations that are tapered, cross-shaped, protruding or curving outwardly and inwardly, slanted, and T-shaped. Voids 535 may be any of these shapes, as well as other shapes, to impart desired properties to cushioning element 500, such as flex, stretch, compressibility, and breathability, for example. Through selecting a shape for one or more of voids 535, therefore, particular properties may be imparted to cushioning element 500. For example, tapered and T-shaped voids 535 may permit cushioning element 500 to flex more in one

direction than in an opposite direction. Moreover, various non-uniform shapes for voids 535 (e.g., tapered, cross-shaped, protruding or curving, slanted, and T-shaped) may be utilized to limit the ability of objects to protrude through voids 535, thereby contacting the individual wearing apparel 100, while imparting the desired properties to cushioning element 500. Similarly, different grooves 534 and voids 535 may have different widths or shapes to further vary the properties of cushioning element 500. Although many of the concepts presented above are discussed in relation to voids 535, any of these concepts may also be applied to grooves 534.

[103] Another aspect relating to pad component 530 that may modify the properties or aesthetics of cushioning element 500 relates to forming a layered structure, as depicted in Figure 31B. As an example, the layers may be different types of polymer foam or densities of polymer foam, or the layers may be different materials, such as polymer foam and rubber. The layers may also have different colors to impart aesthetic qualities to cushioning element 500. For example, voids 535 may extend through one layer and into the other layer to expose the color of the underlying layer. Moreover, voids 535 are depicted as being tapered so that the color of the underlying layer may be seen, thereby enhancing the aesthetic attributes of cushioning element 500. A similar concept may apply to grooves 534, which may extend through one layer and into the other layer to expose the color of the underlying layer.

[104] Although the thickness of pad component 530 may be constant, pad component 530 may also have varying or tapered thicknesses, as depicted in Figure 31C, to further modify the properties or aesthetics of cushioning element 500. In some configurations of cushioning element 500, a central area of pad component 530 may have greater thickness than a peripheral area of pad component 530, as depicted in Figure 31D. Additionally, pad component 530 may have a rounded or contoured shape, as depicted in Figure 31E, to better conform with contours of individual 10.

[105] Further configurations of pad component 530 are depicted in Figures 32 and 33. These configurations of pad component 530 may be utilized, for example, in a thigh area or a hip area of apparel 100. As with configurations of pad

component 530 discussed above, these configurations include grooves 534 and voids 535 that cross each other and extend in various directions, as well as having beveled edge 536. Moreover, these configurations of pad component 530 incorporate combinations and orientations of grooves 534 and voids 535 in specific areas in order to impart varying degrees of flex, stretch, compressibility, and breathability, for example. Accordingly, many of the features and variations discussed above may be incorporated into one pad component 530 to provide different combinations of properties to different areas of cushioning element 500.

[106] Third Cushioning Element Configuration

[107] An example of a cushioning element 600 that may also be incorporated into apparel 100 or other articles of apparel (e.g., the articles of apparel in Figures 17A-17G) is depicted in Figures 34-37A. Cushioning element 600 may replace either of cushioning elements 200 and 500, or cushioning element 600 may be used with one or more of cushioning elements 200 and 500 in apparel 100 or the other articles of apparel. The primary components of cushioning element 600 include a first material layer 610, a second material layer 620, and a pad component 630. First material layer 610 and second material layer 620 are secured to opposite sides of pad component 630 and cooperatively form an outer surface or covering for cushioning element 600. That is, first material layer 610 and second material layer 620 cooperatively form a pocket or void, in which pad component 630 is located. In addition to attenuating impact forces, pad component 630 includes various grooves 634 and voids 635 that enhance the flex, stretch, and breathability of cushioning element 600. Although pad component is depicted as including both of grooves 634 and voids 635, pad component 630 may also include only grooves 634 or only voids 635. Additional advantages of cushioning element 600 include compressibility, relatively low overall mass, and launderability.

[108] The overall configuration of cushioning element 600 is similar to each of cushioning elements 200 and 500. As such, many of the features and variations discussed above also apply to cushioning element 600. For example, cushioning element 600 may exhibit any of the shapes depicted in

Figures 14A-14I, 32 and 33, as well as any other practical shape. Many of the materials discussed above for elements of cushioning elements 200 and 500 may also be utilized for first material layer 610, second material layer 620, and pad component 630. Moreover, many of the variations discussed above for pad components 230 and 530 may also be applied to pad component 630 and the various grooves 634 and voids 635 formed in pad component 630, such as any of the configurations depicted in Figures 15A-15J, 16A-16R, 19-21, and 25A-31E. Accordingly, many of the concepts discussed above in relation to cushioning elements 200 and 500 may also be applied to cushioning element 600.

[109] Opposite surfaces of pad component 630 include a bonding agent 637 that enhances bonding between pad component 630 and material layers 610 and 620. Bonding agent 637 may be an adhesive or thermoplastic polymer material, for example, that is located on the opposite surfaces of pad component 630, but is absent from within the various grooves 634 and voids 635. During the manufacturing of cushioning element 600, bonding agent 637 effectively secures each of material layers 610 and 620 to the opposite surfaces of pad component 630. Moreover, applying bonding agent 637 to the surfaces of pad component 630 prior to the formation of grooves 634 and voids 635 may ensure that bonding agent 637 is absent from within grooves 634 and voids 635. For example, when thermoplastic polymer sheets are utilized as bonding agent 637, the thermoplastic polymer sheets may be bonded or secured to opposite sides of a polymer foam member (i.e., the polymer foam member that forms pad component 630). Then, grooves 634 and voids 635 may be formed using a router or other process, which effectively removes portions of the thermoplastic polymer sheets located at grooves 634 and voids 635. As such, the thermoplastic polymer sheets are absent from grooves 634 and voids 635 and effectively limited to the areas of pad component 630 that bond with material layers 610 and 620. Accordingly, by selecting a particular order for the manner in which components of cushioning element 600 are applied, excess materials that may form unintended bonds or detract from the aesthetic properties of cushioning element 600 may be avoided.

- [110] An advantage of cushioning element 600 relates to the visibility of pad component 630. When one or both of material layers 610 and 620 are formed from an at least partially transparent material, as shown in Figures 34-36, pad component 630 may be visible within cushioning element 600. Moreover, the various grooves 634 and voids 635 may also be visible. When an individual is selecting apparel 100 or other articles of apparel that incorporate cushioning element 600, the ability to see grooves 634 and voids 635 provides the individual with information regarding the flex and breathability properties of cushioning element 600. The individual may also determine, based upon the positions of grooves 634 and voids 635, whether the apparel incorporating cushioning element 600 will flex and breathe in a manner that is suitable for the particular activities the individual intends to engage in. Additionally, when selecting between various articles of apparel that incorporate cushioning elements 600, the individual may select the apparel with the most suitable positions of grooves 634 and voids 635. A related advantage of cushioning element 600 relates to the aesthetics of the visibility of pad component 630.
- [111] In order to enhance the visibility of grooves 634 and voids 635, bonding agent 637 and the polymer foam material forming other areas of pad component 630 may exhibit different colors. For example, bonding agent 637 may be formed to have a black color, whereas the polymer foam material may be formed to have one of the primary or secondary colors (e.g., red, orange, yellow, green, blue, violet). As another example, bonding agent 637 and the polymer foam material may be formed to have different primary or secondary colors, or one of bonding agent 637 and the polymer foam material may have a white color. Accordingly, by forming bonding agent 637 and the polymer foam material to have different and visually-distinguishable colors, the visibility of grooves 634 and voids 635 may be enhanced.
- [112] As noted above, pad component 630 may be visible within cushioning element 600 when one or both of material layers 610 and 620 are formed from an at least partially transparent material. Examples of materials that may be utilized include clear or non-opaque polymer sheets, perforated materials, and mesh or lace textiles. Referring to Figure 38, for example, first material

layer 610 is depicted as being a mesh textile that permits visibility of pad component 630, including each of grooves 634, voids 635, and bonding agent 637.

- [113] A further feature that enhances visibility relates to the configuration of grooves 634 and voids 635. Referring to Figures 37A and 37B, for example, grooves 634 are formed to have a v-shaped structure and voids 635 slant downward to impart varying widths. In effect, these configurations for grooves 634 and voids 635 ensure that the surfaces of the polymer foam material are visible from the exterior of cushioning element 600. That is, the color of grooves 634 and voids 635 may be more visible when grooves 634 and voids 635 have slanting or sloped surfaces that are oriented to be visible from the exterior of cushioning element 600.
- [114] Although bonding agent 637 may be incorporated into pad component 630, bonding agent 637 may be absent in some configurations of cushioning element 600. In these configurations, one or both of the surfaces of pad component 630 may be formed to have a first color and the interior of pad component 630 may have a second color. Given that grooves 634 and voids 635 expose the interior of pad component 630, the second color will be visible at the locations of grooves 634 and voids 635. Accordingly, grooves 634 and voids 635 may be both visible and visually-distinguishable from the surfaces of pad component 630 in configurations where bonding agent 637 is absent.
- [115] Based upon the above discussion, grooves 634 and voids 635 may be visible when (a) one or both of material layers 610 and 620 are at least partially transparent and (b) bonding agent 637 and the polymer foam material of pad component 630 are formed to have different or visually-distinguishable colors. In addition to enhancing the aesthetics of apparel 100, this configuration ensures that an individual may see the structure of pad component 630 and the positions of grooves 634 and voids 635, thereby ensuring that will flex and breathe in a manner that is suitable for the particular activities the individual intends to engage in.

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

CLAIMS:

1. An article of apparel incorporating at least one cushioning element for attenuating impact forces, the cushioning element comprising:
 - a first material layer and a second material layer, the first material layer being formed from an at least partially transparent material; and
 - a pad component located between the first material layer and the second material layer, the pad component including a first surface and an opposite second surface, the first surface facing the first material layer, and the second surface facing the second material layer, and the pad component including a polymer foam material that defines (a) a plurality of elongate grooves that extend from the first surface toward the second surface and (b) a plurality of elongate voids that extend through the pad component and from the first surface to the second surface, the first surface including a bonding agent comprising a colored thermoplastic polymer sheet that joins the pad component to the first material layer, the polymer foam material having a first color and the colored thermoplastic polymer sheet having a second color that is different than the first color.
2. The article of apparel recited in claim 1, wherein the first material layer is a mesh textile.
3. The article of apparel recited in claim 1, wherein the first color is visually-distinguishable from the second color.
4. The article of apparel recited in claim 1, wherein at least one of the grooves and the voids have sloping surfaces.
5. An article of apparel incorporating at least one cushioning element for attenuating impact forces, the cushioning element comprising:
 - a first material layer and a second material layer, the first material layer being formed from an at least partially transparent material; and
 - a pad component located between the first material layer and the second material layer, the pad component including a first surface and an opposite second surface, the first surface having a first color and being joined with the first material layer, and the

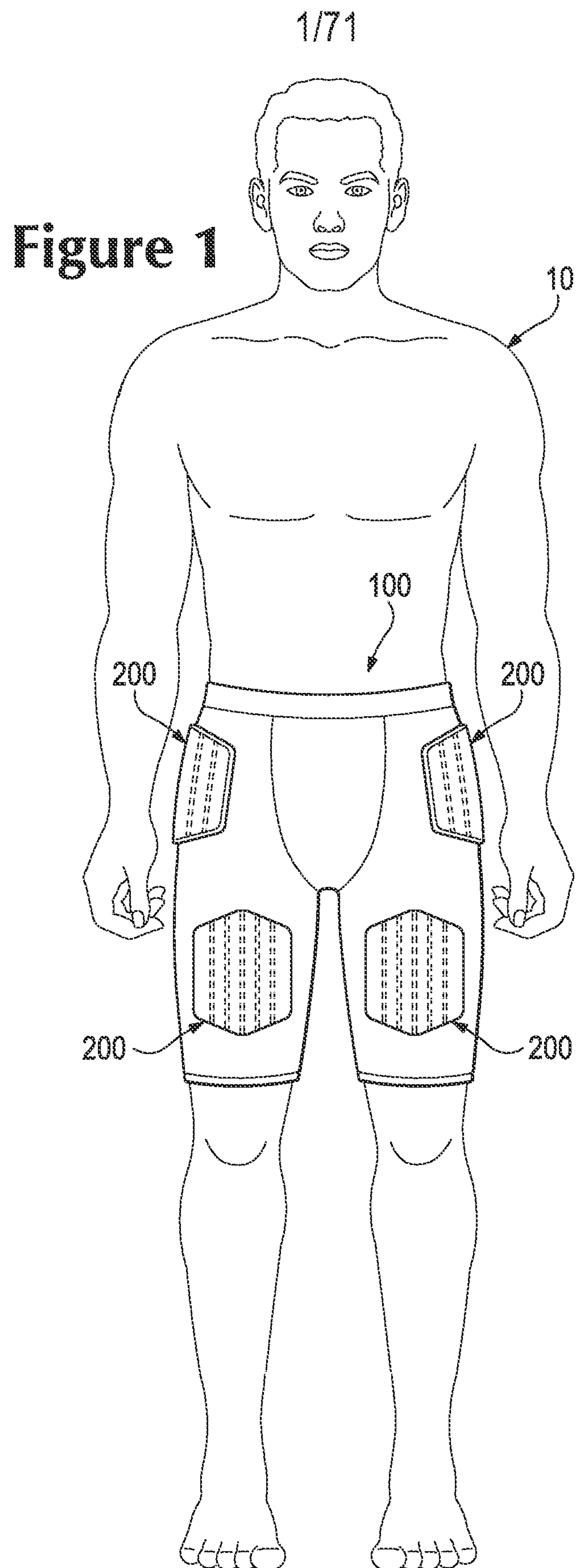
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second surface being joined with the second material layer, and the pad component including at least one of (a) a plurality of elongate, slope-sided grooves that extend from the first surface toward the second surface and that have sloping surfaces that angle towards one another as the sloping surfaces extend towards the second surface and (b) a plurality of elongate voids that extend through the pad component and from the first surface to the second surface, the sloping surfaces exposing an interior of the pad component having a second color that is different than the first color.

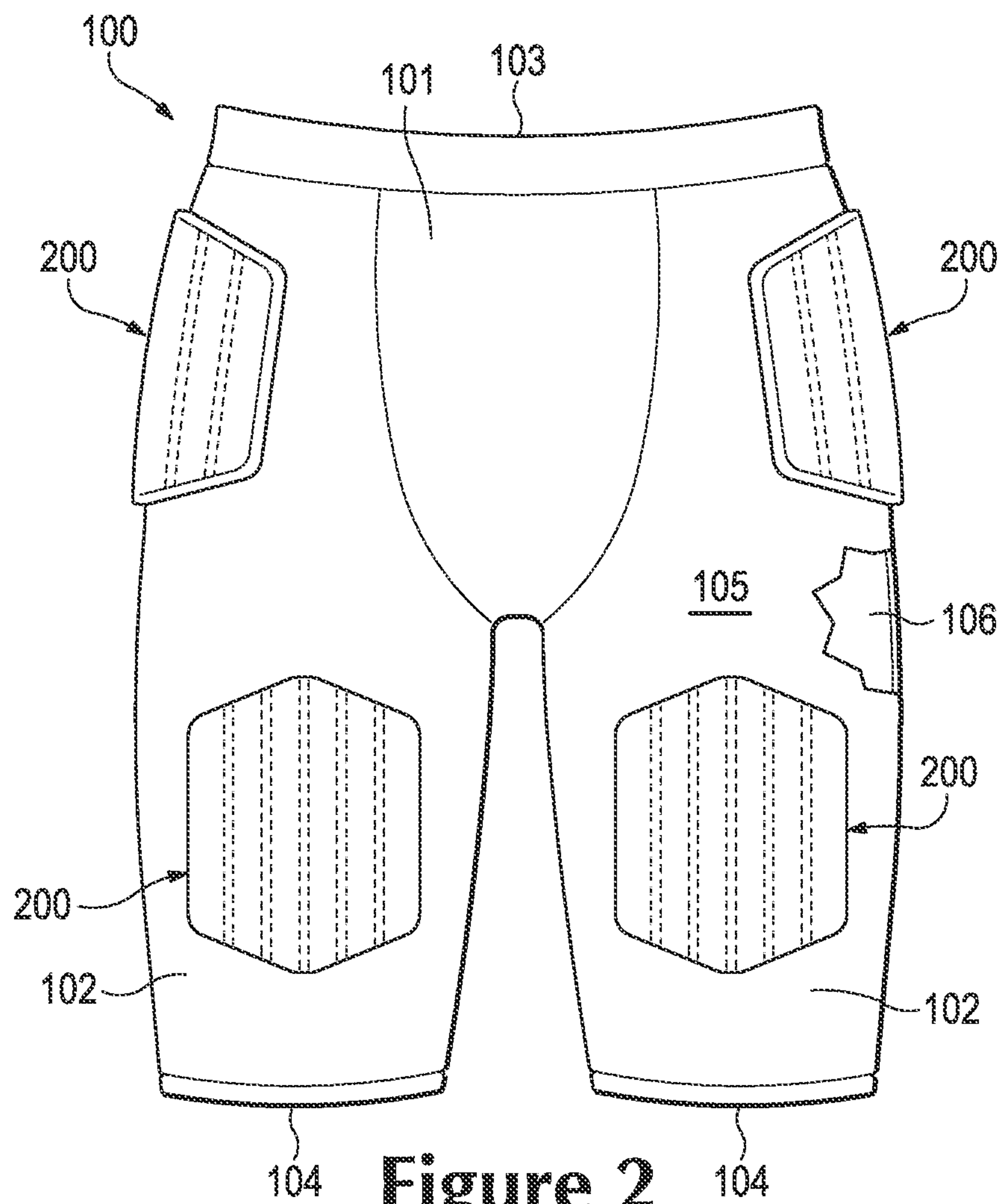
6. The article of apparel recited in claim 5, wherein the first material layer is a mesh textile.

7. The article of apparel recited in claim 5, wherein the voids have sloping surfaces.

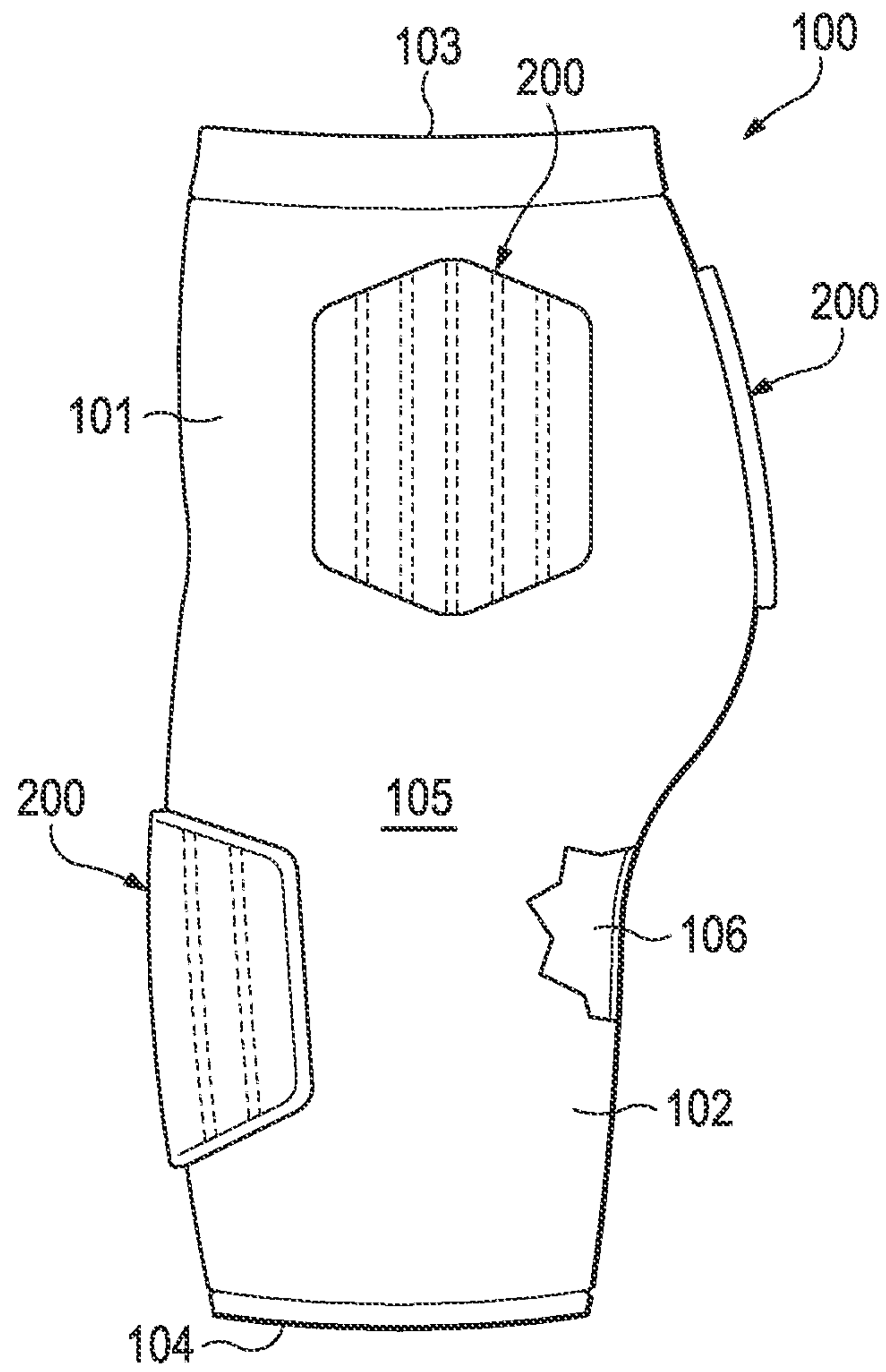
8. The article of apparel recited in claim 5, wherein the first surface includes a bonding agent that joins the pad component to the first material layer, the bonding agent having the first color.



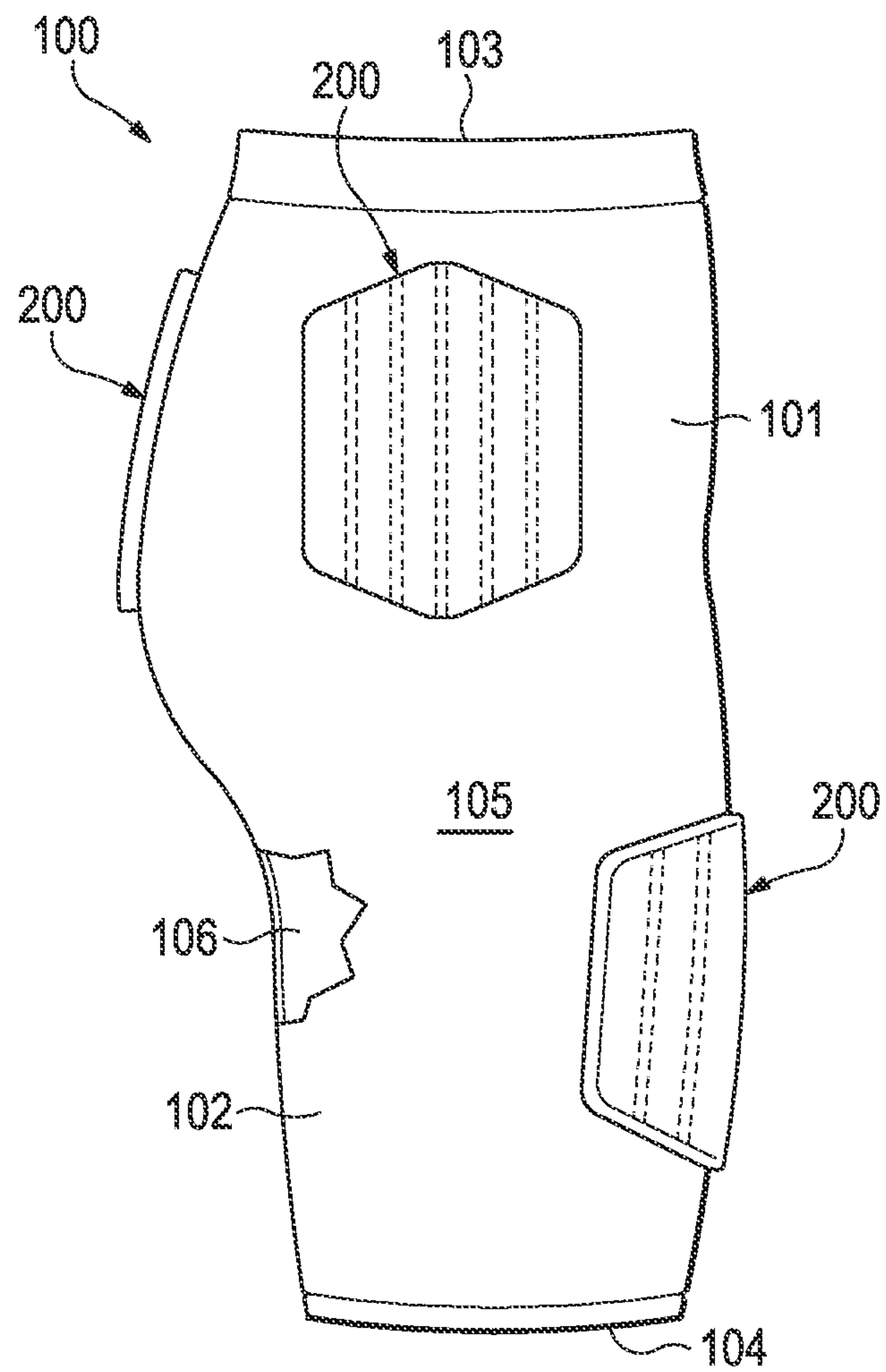
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**Figure 2**

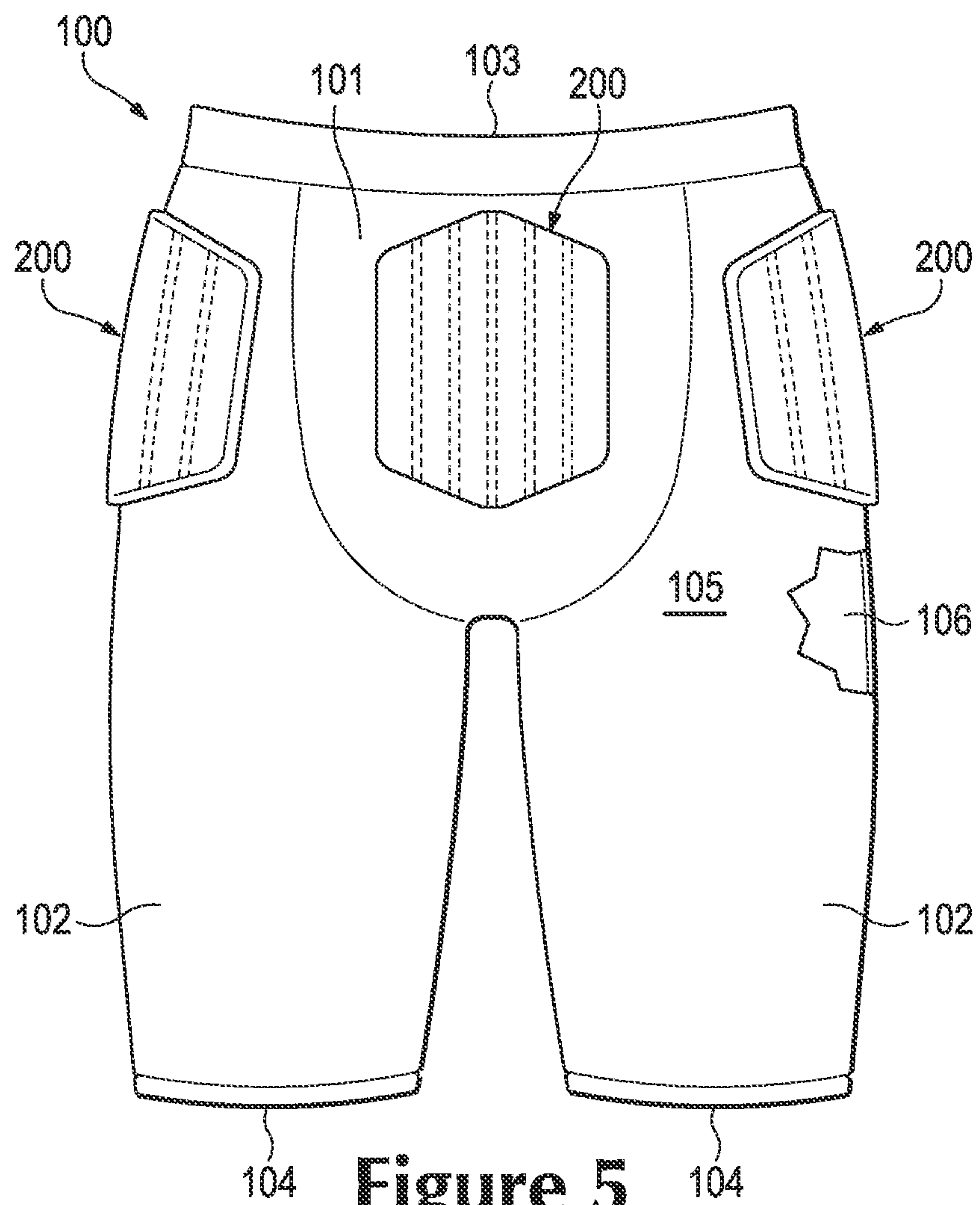
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**Figure 3**

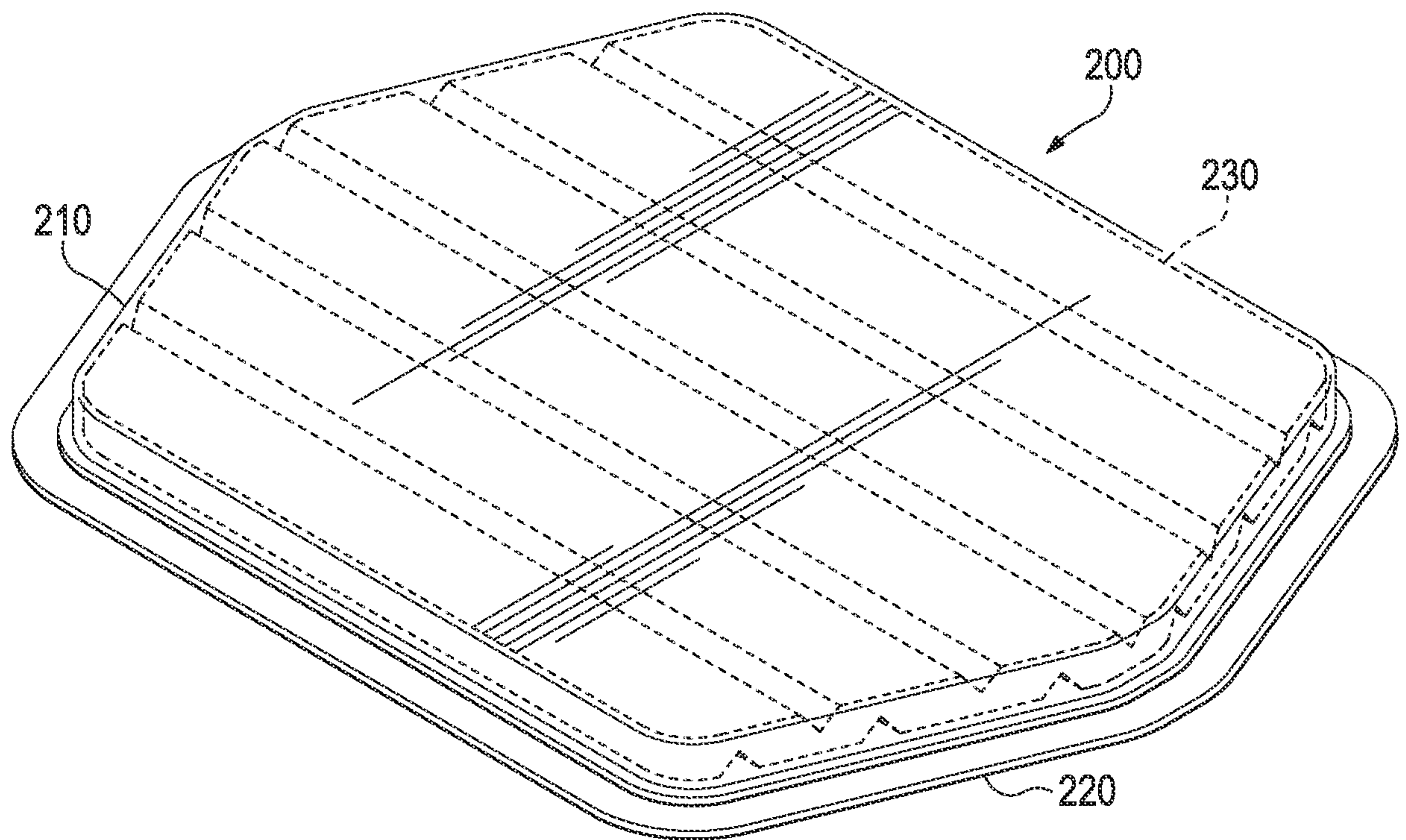
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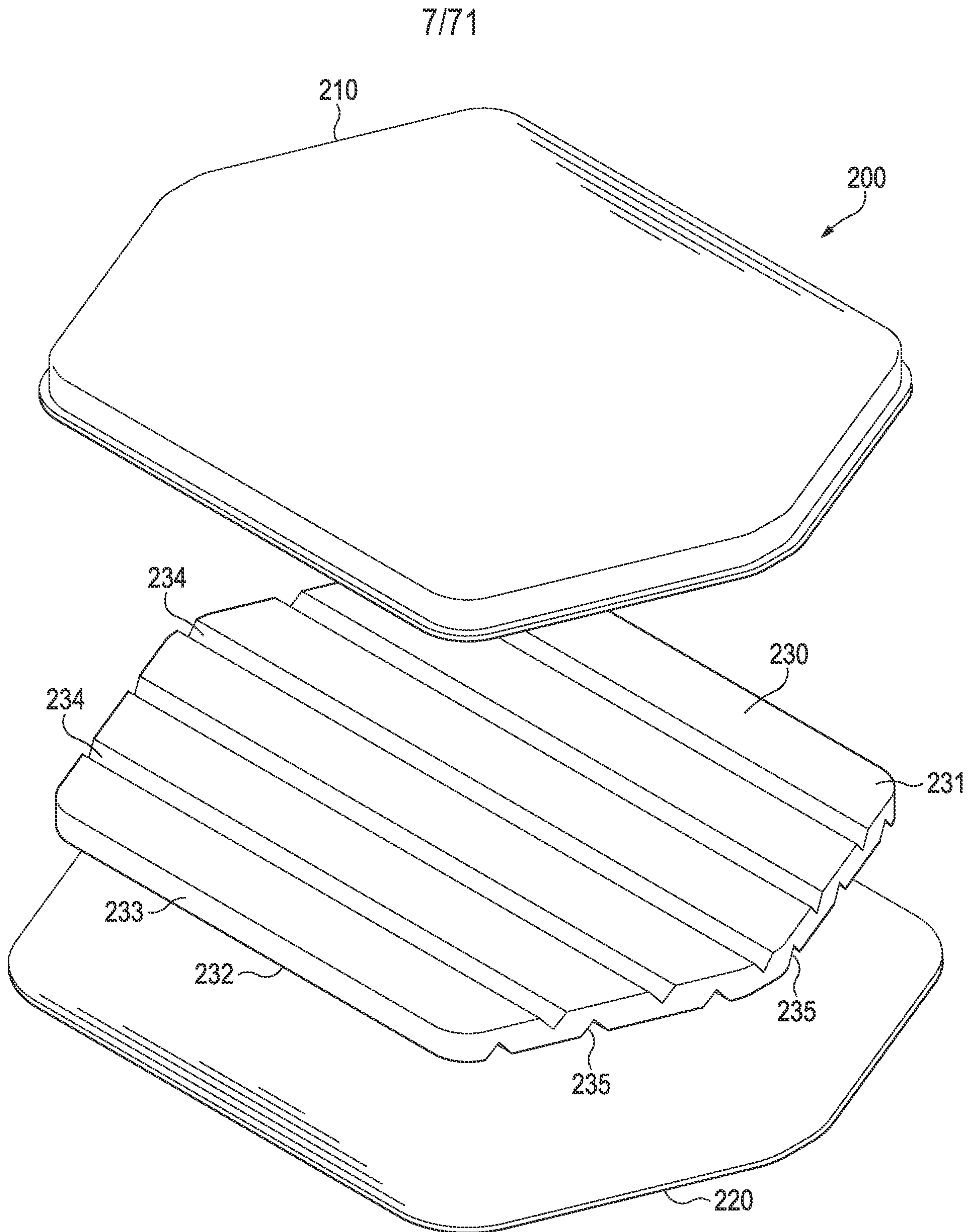
**Figure 4**

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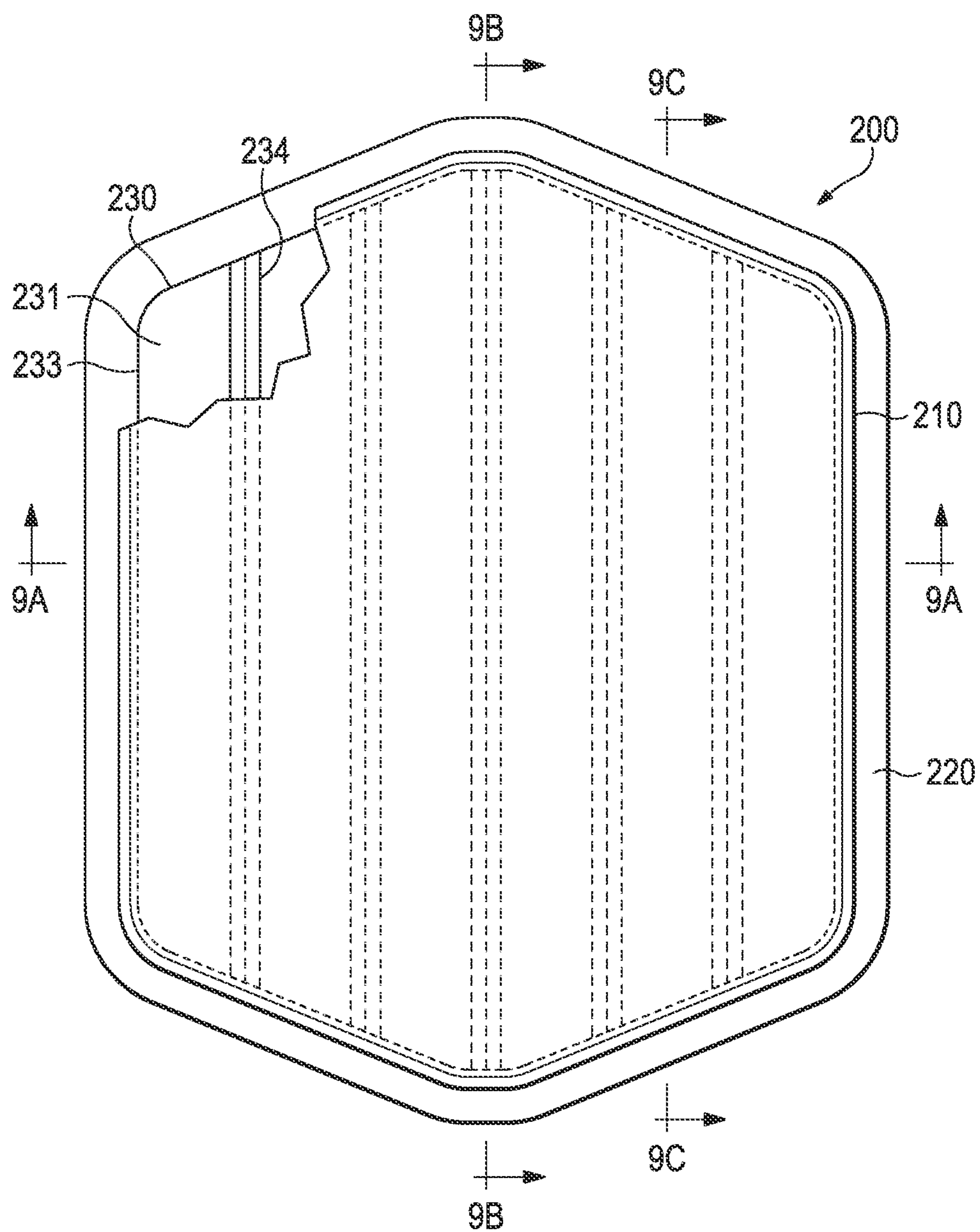
**Figure 5**

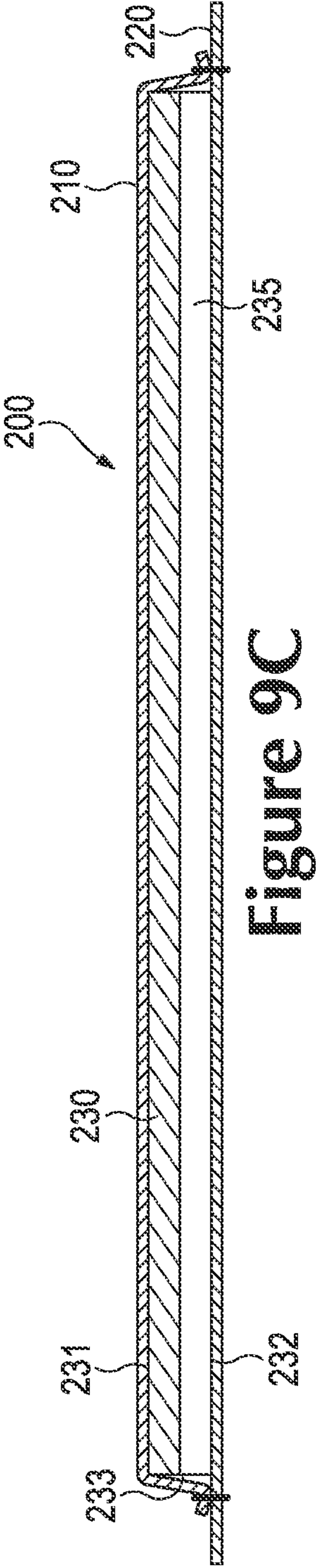
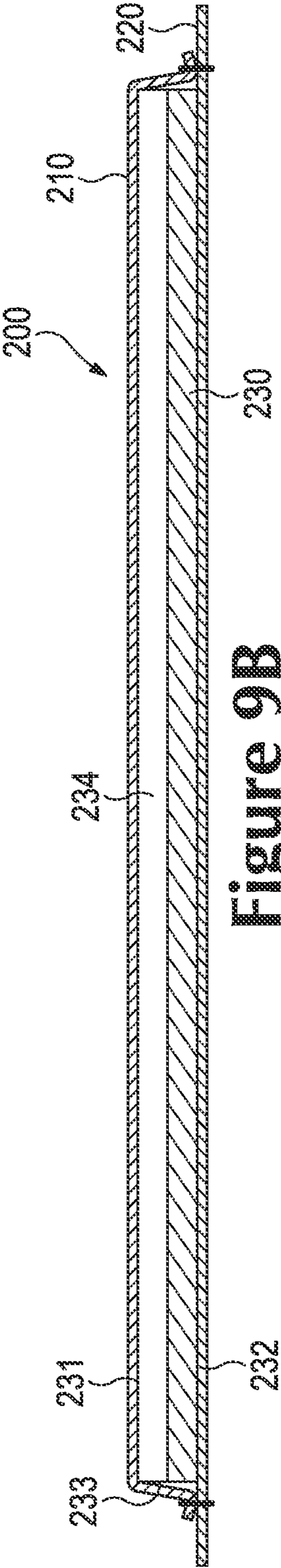
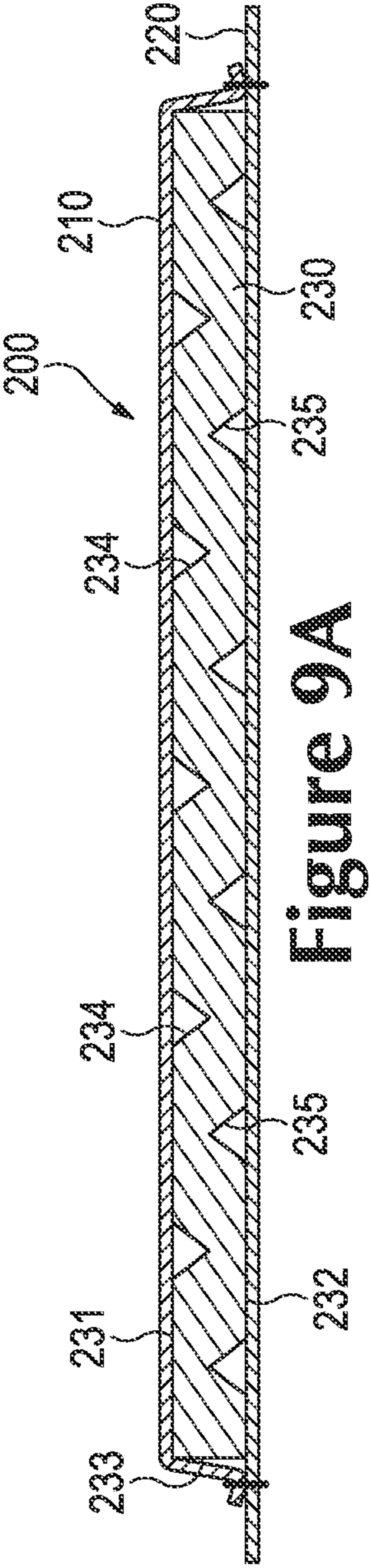
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**Figure 6**

**Figure 7**

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**Figure 8**



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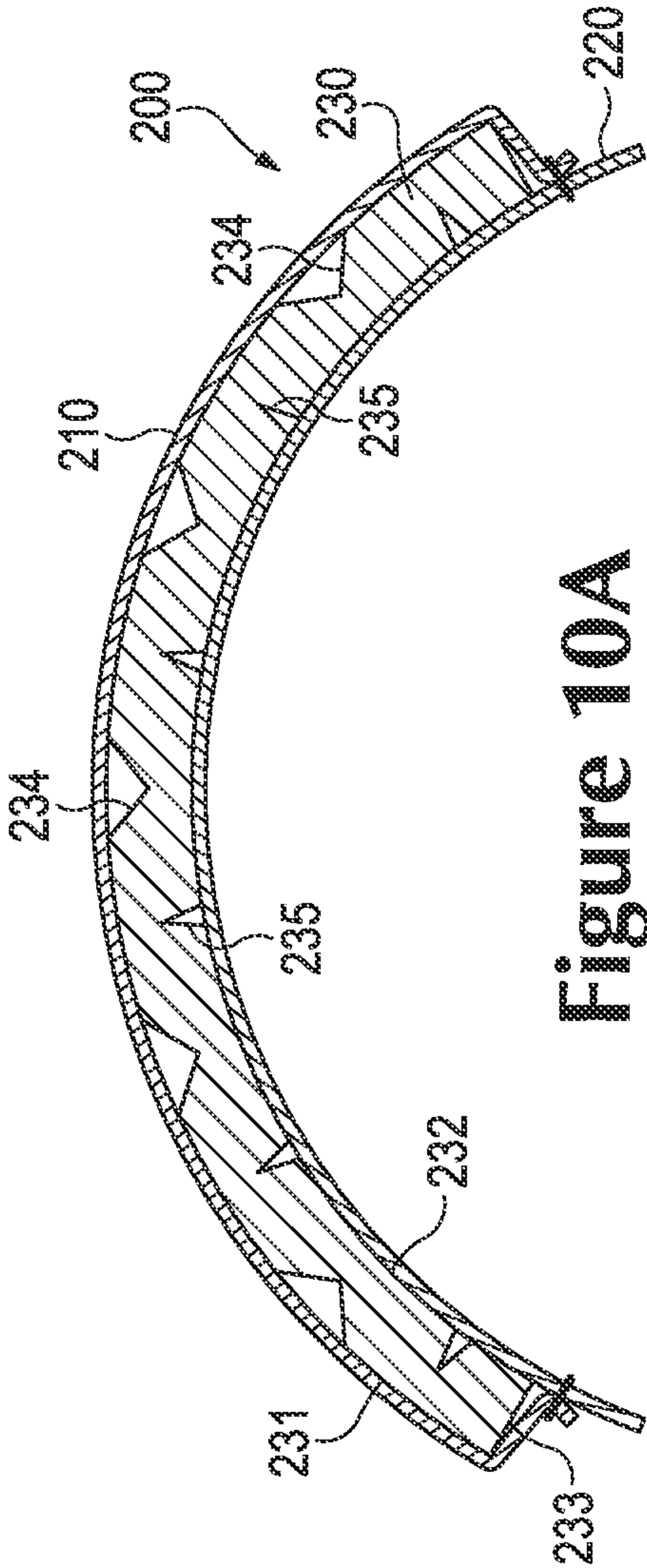


Figure 10A

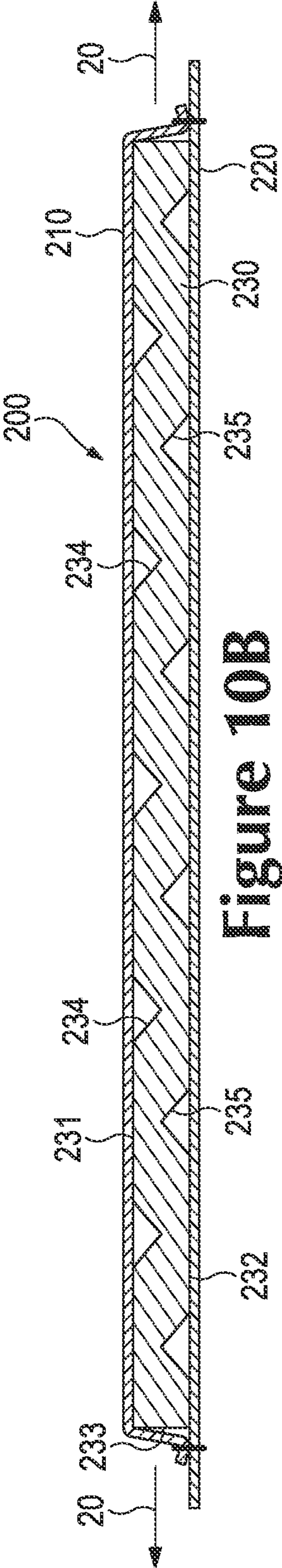


Figure 10B

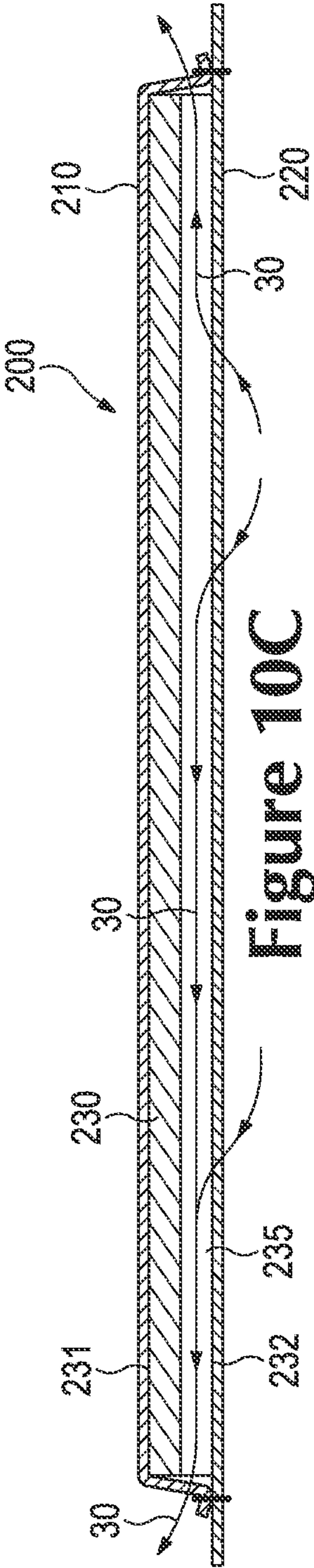
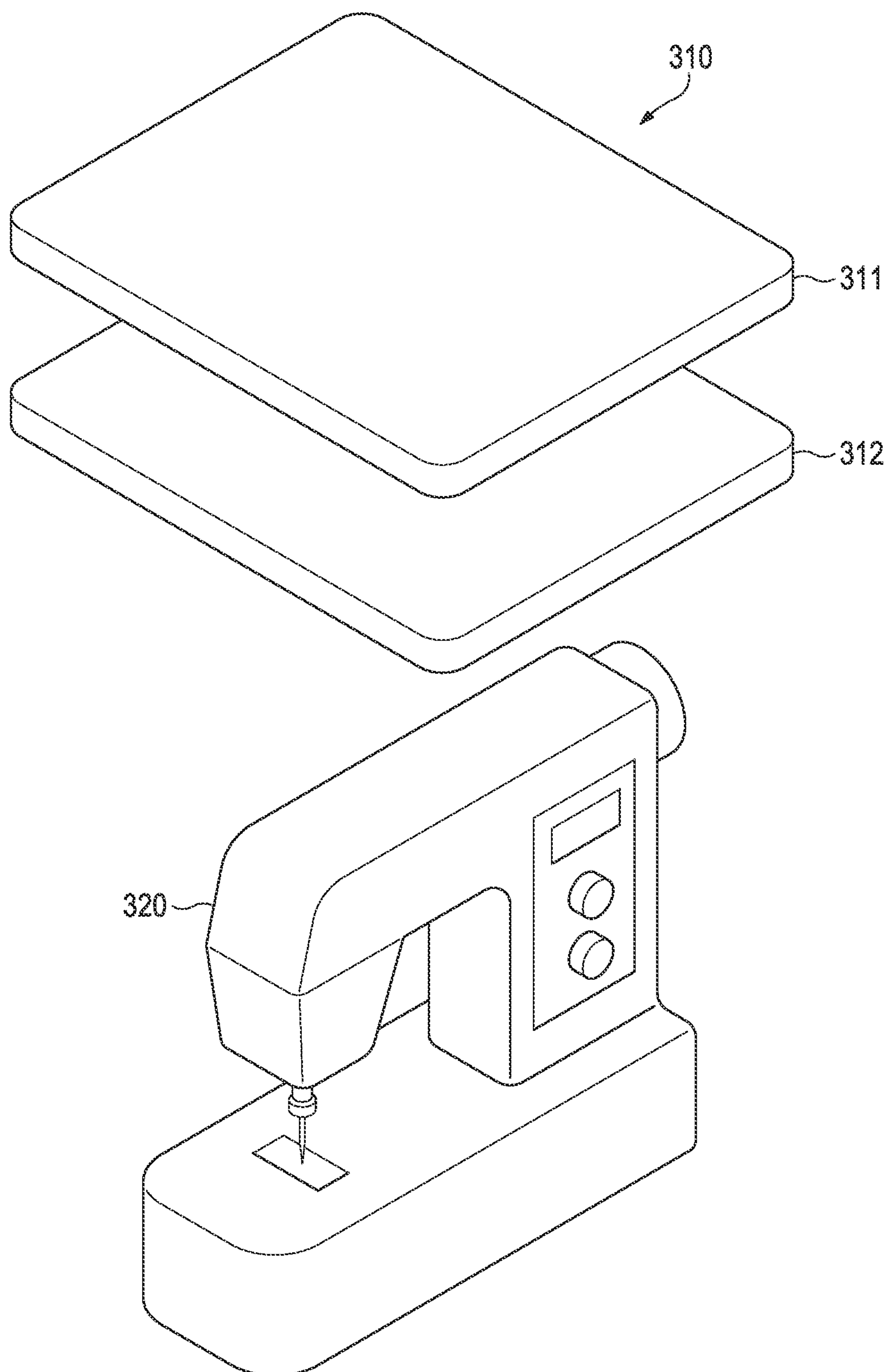
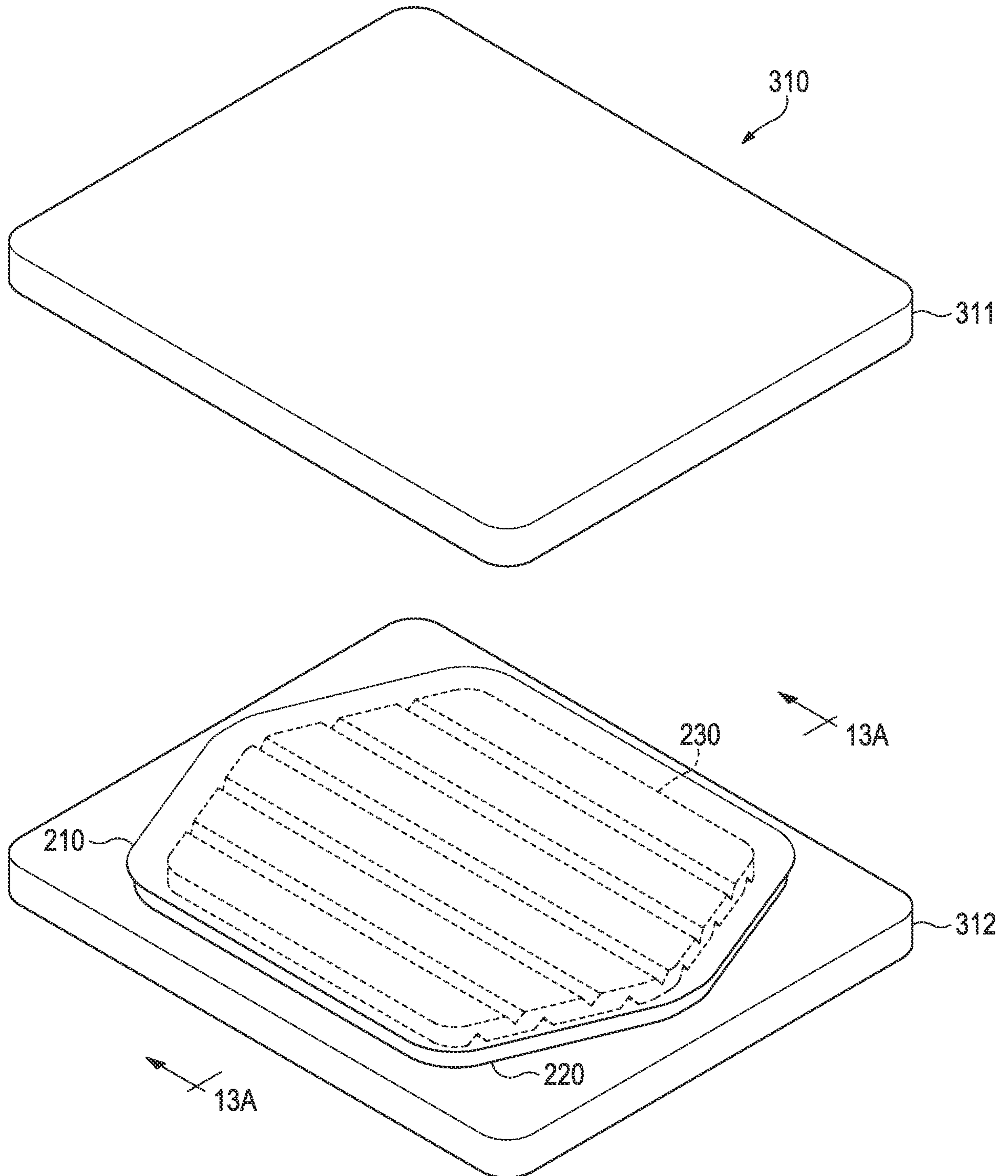


Figure 10C

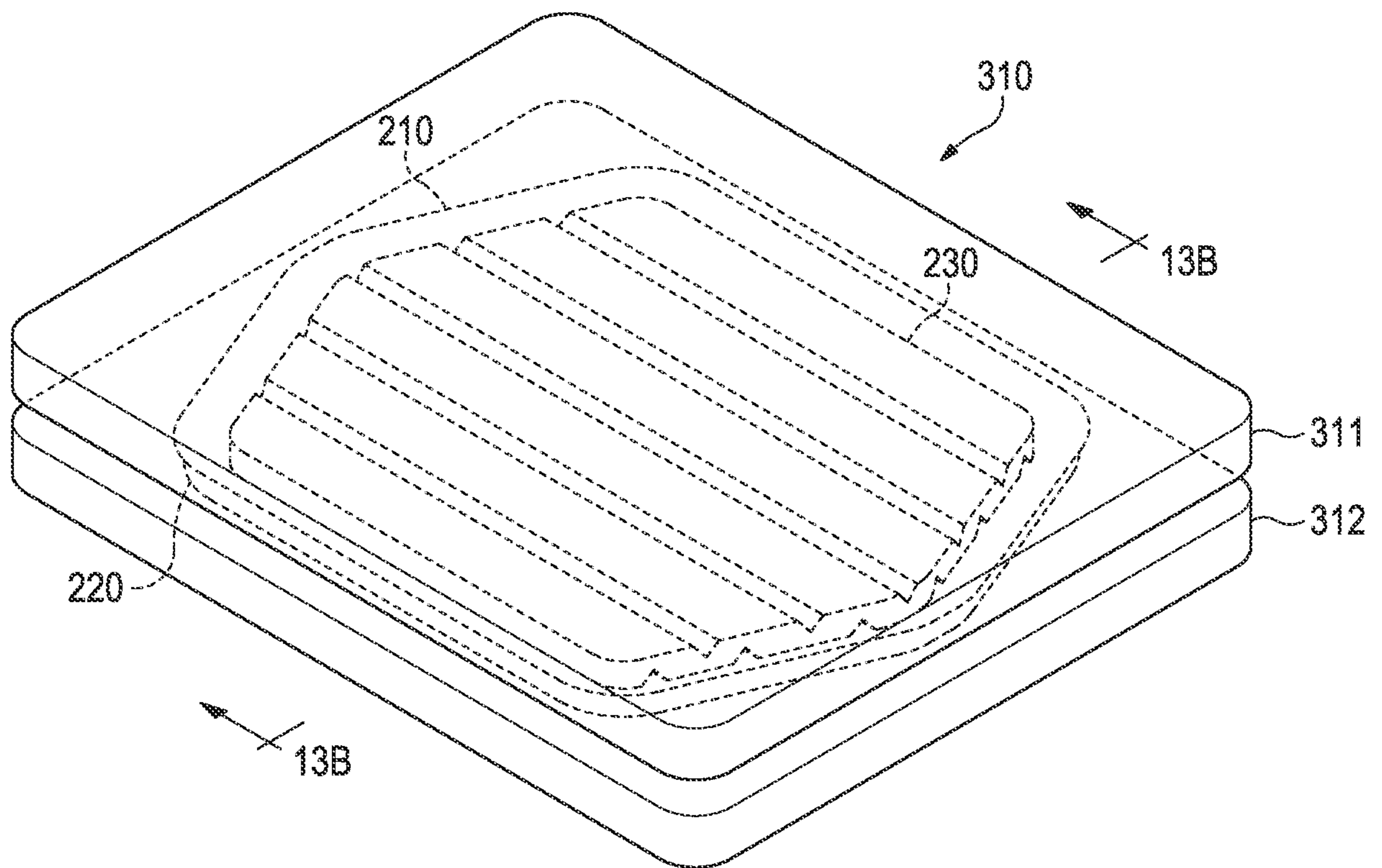
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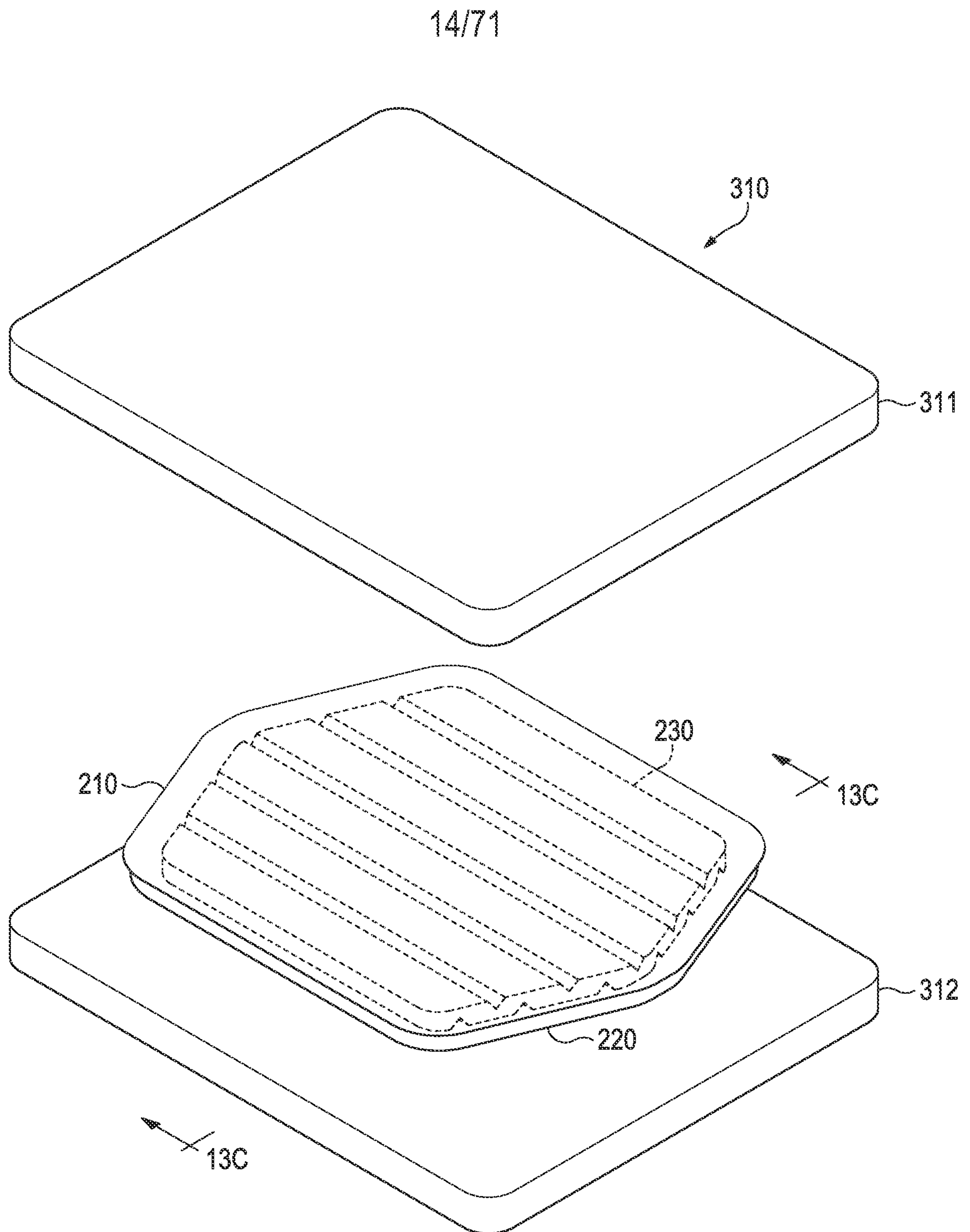
**Figure 11**

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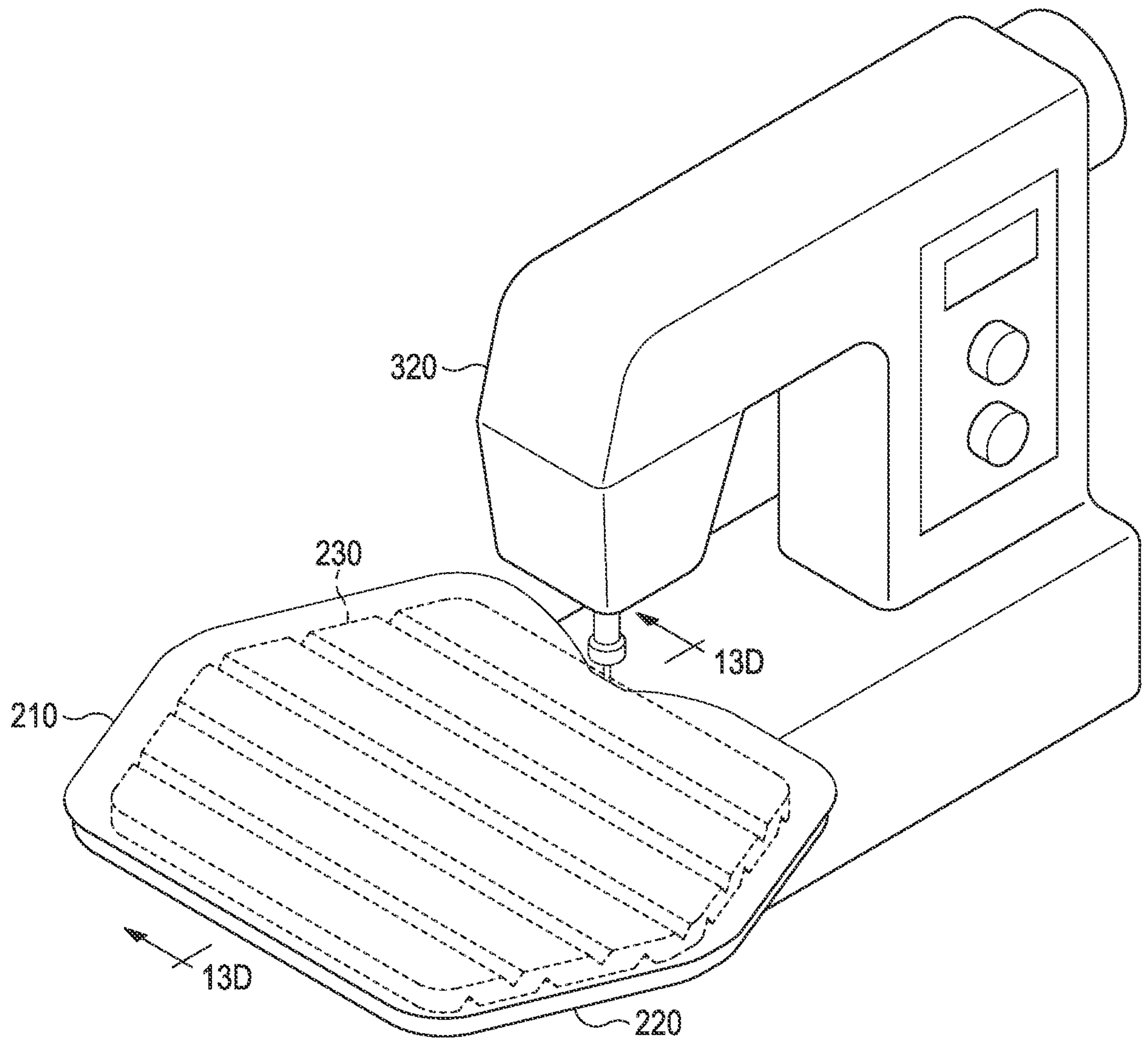
**Figure 12A**

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**Figure 12B**

**Figure 12C**

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**Figure 12D**

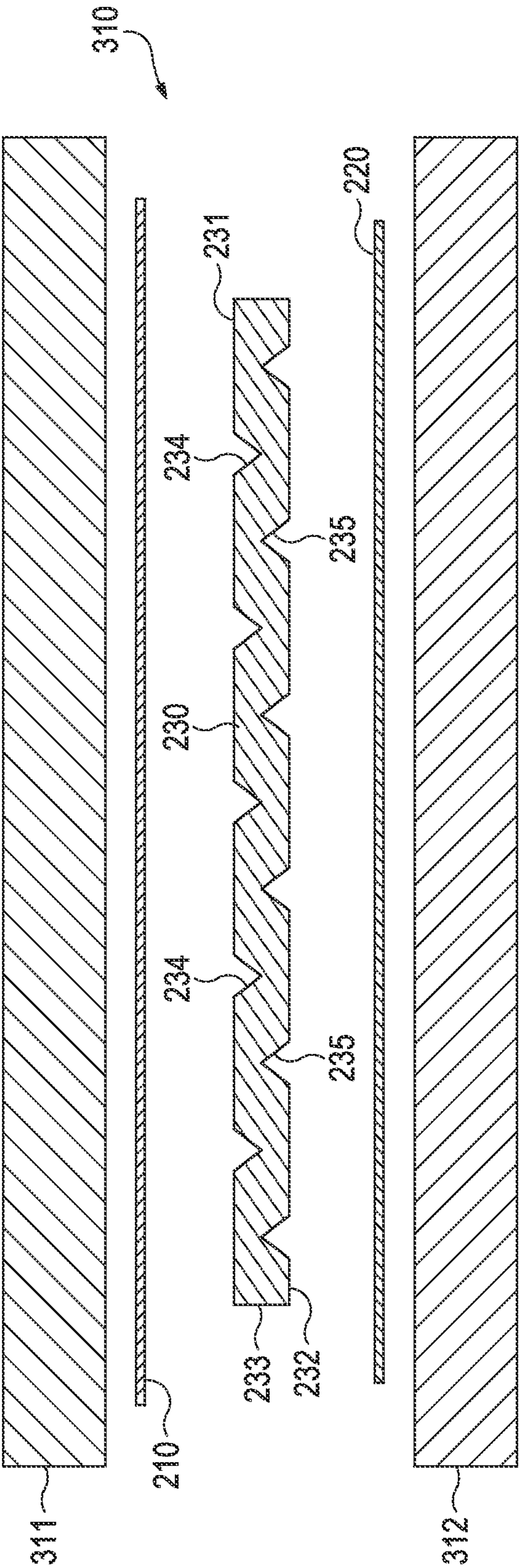


Figure 13A

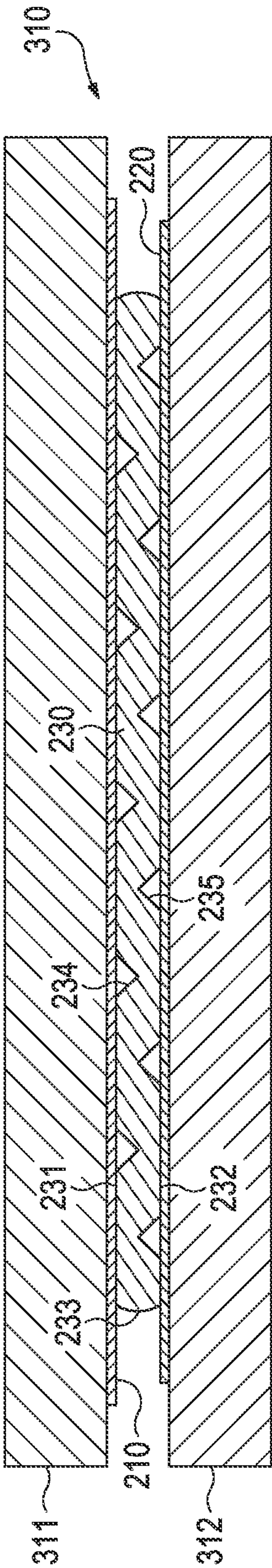


Figure 13B

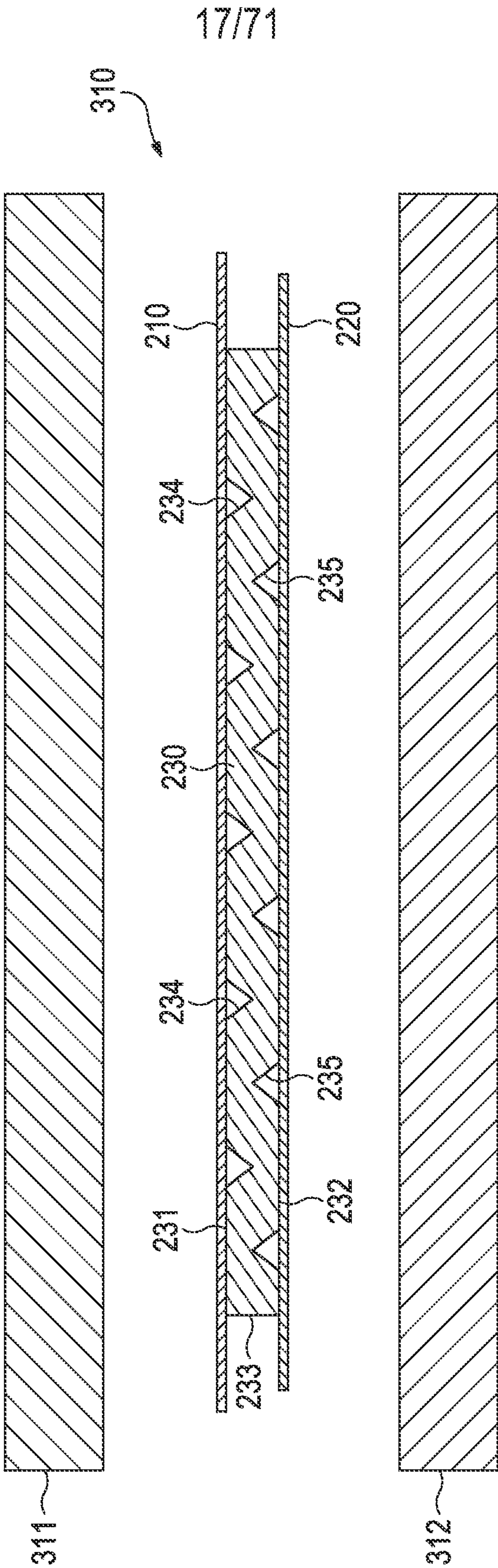
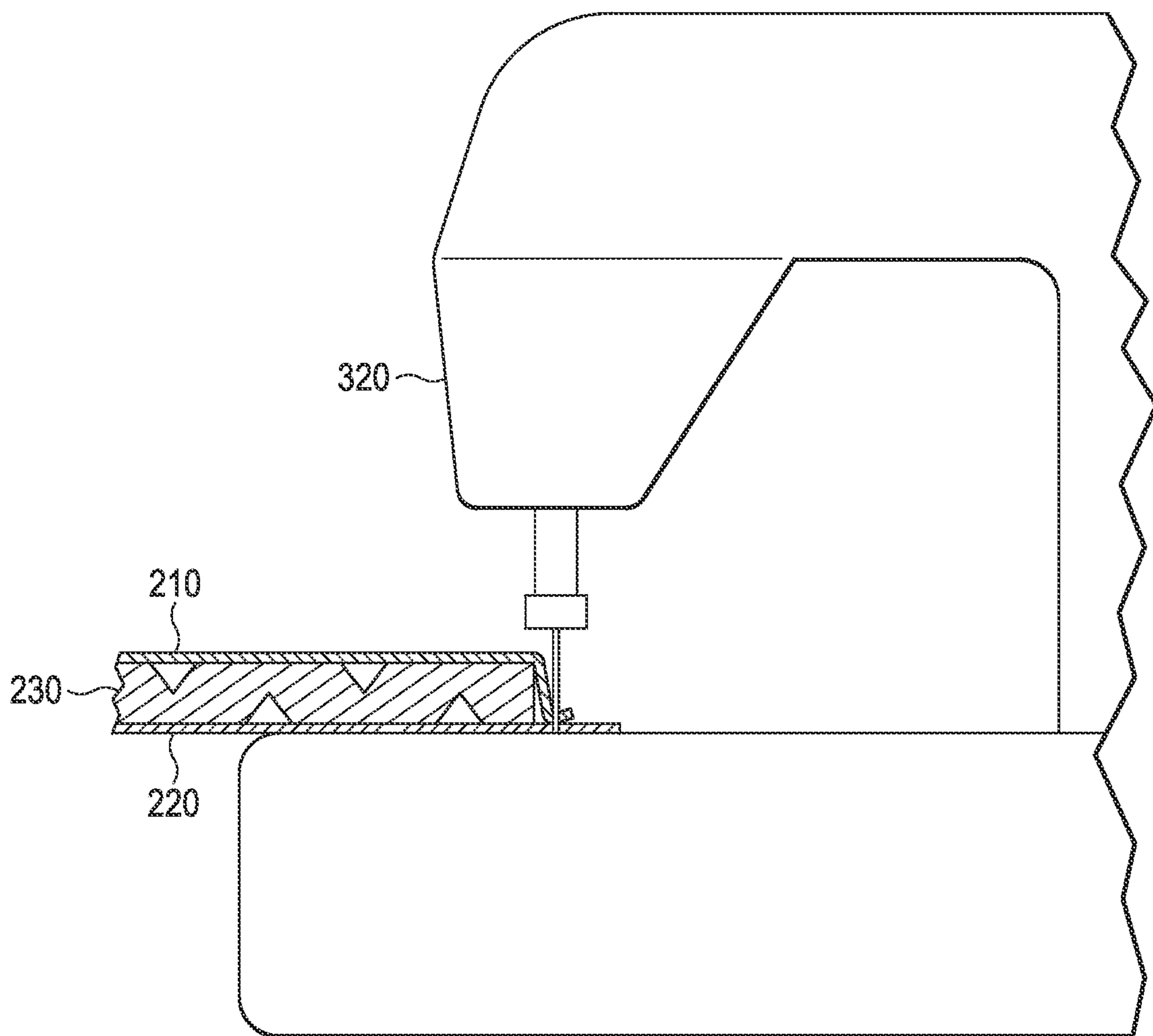
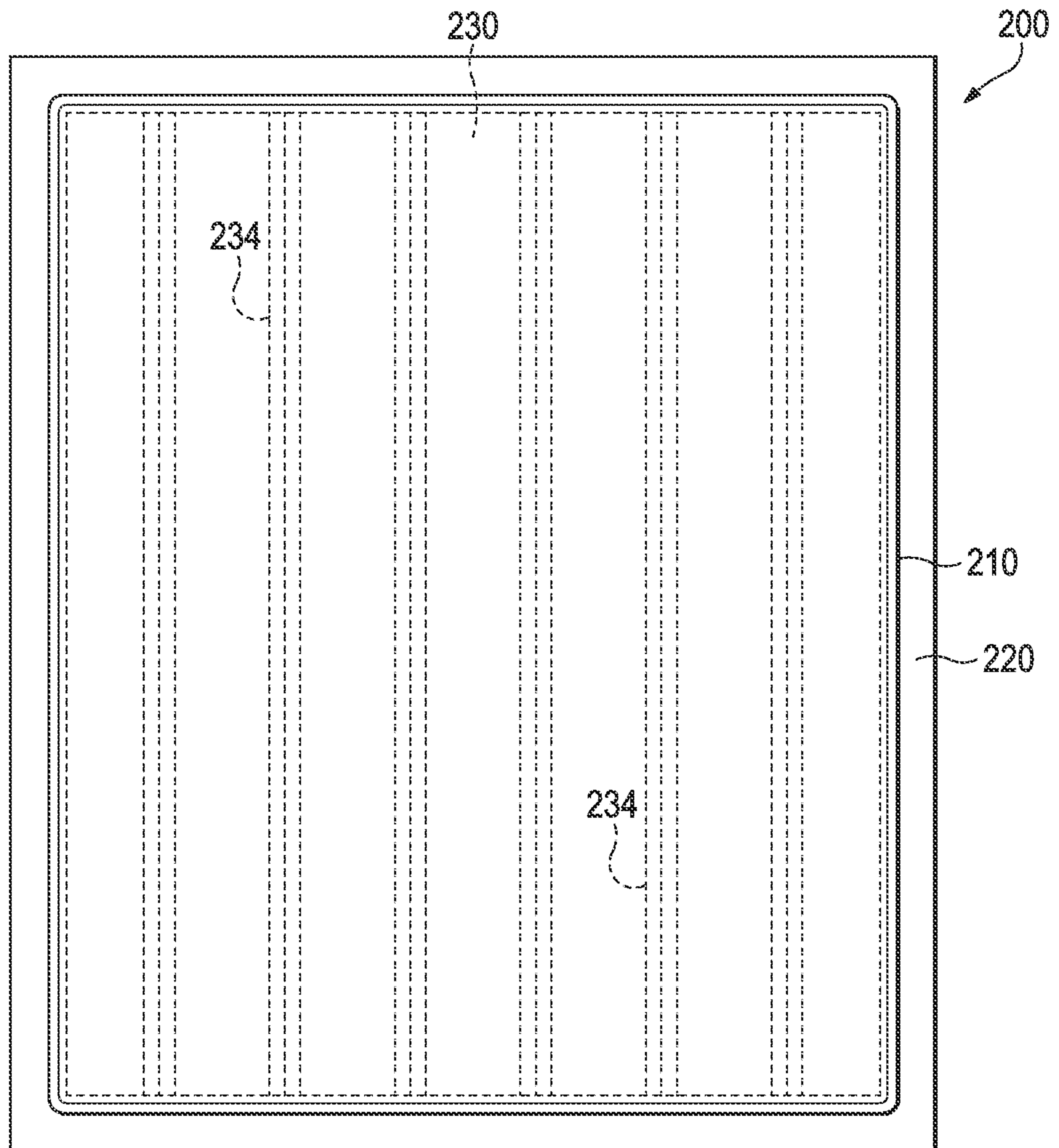


Figure 13C

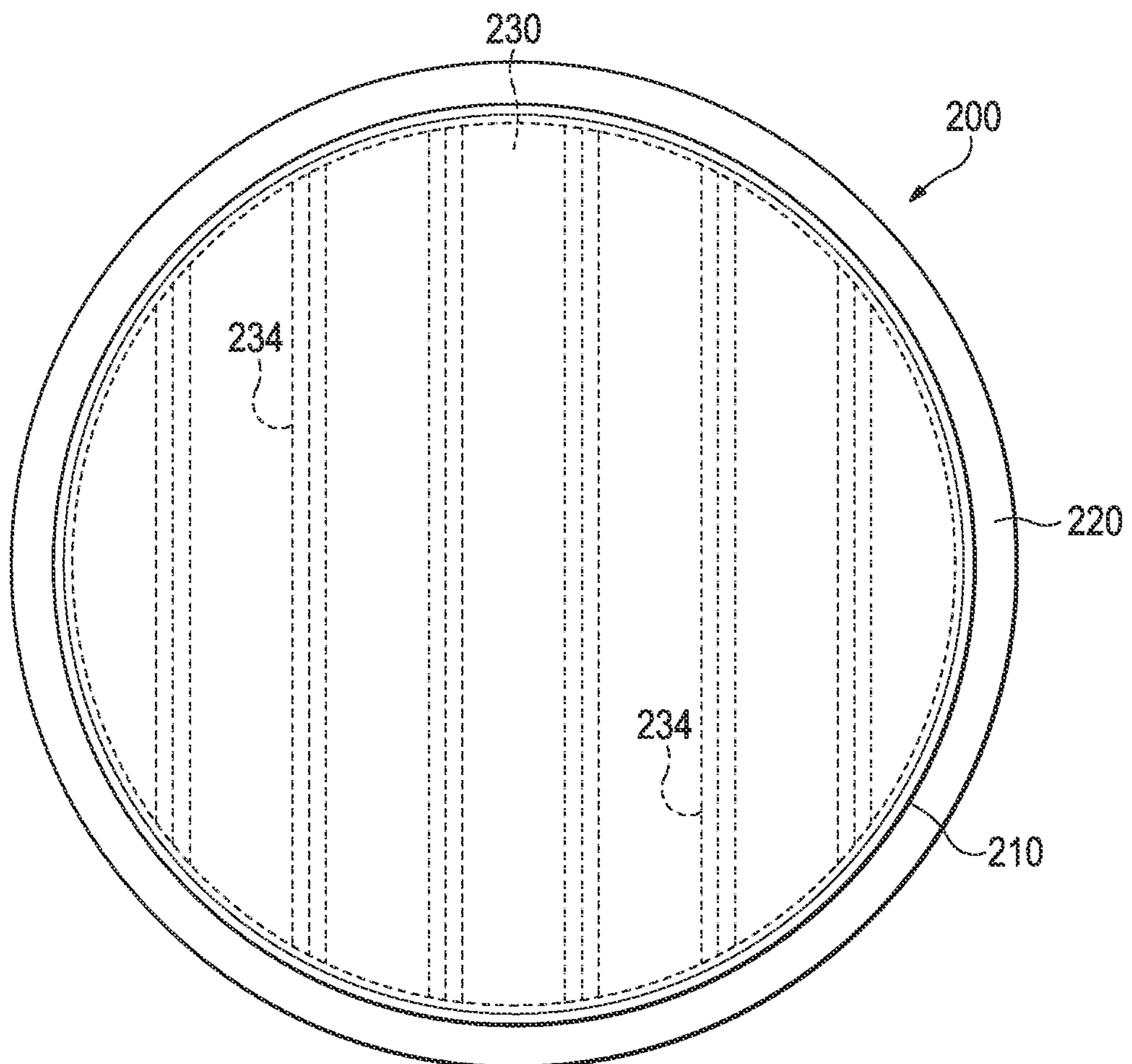
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**Figure 13D**

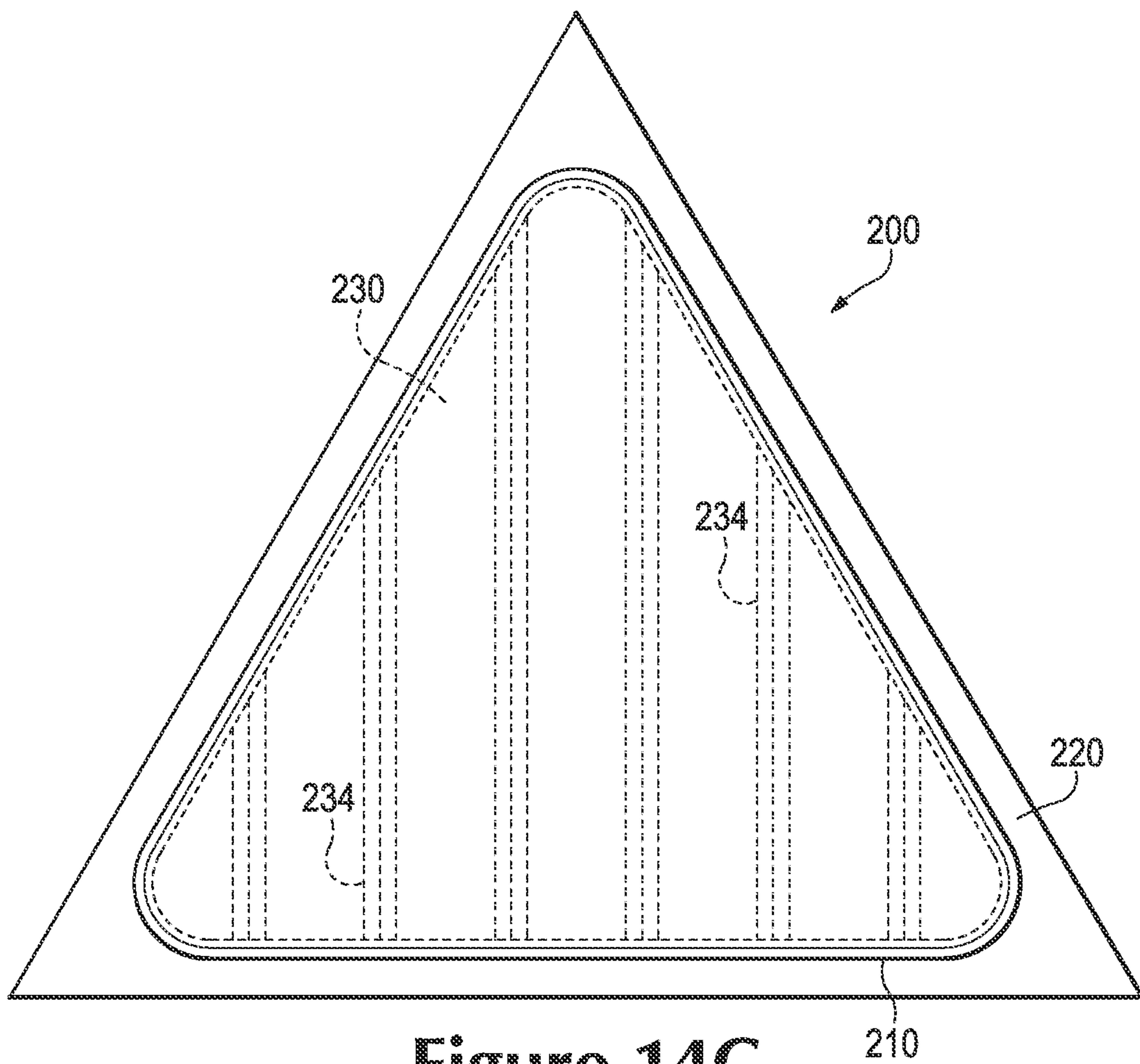
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**Figure 14A**

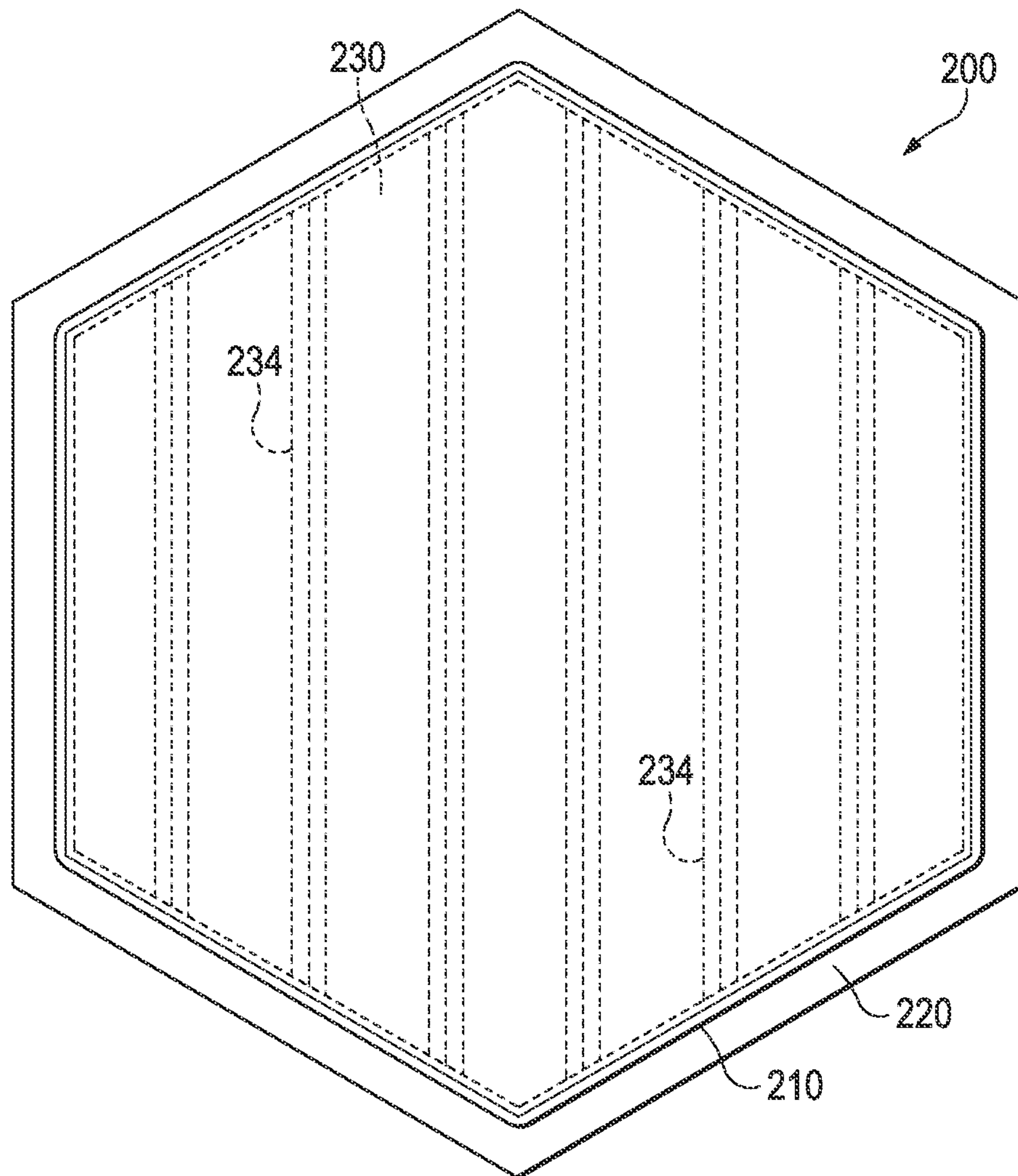
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**Figure 14B**

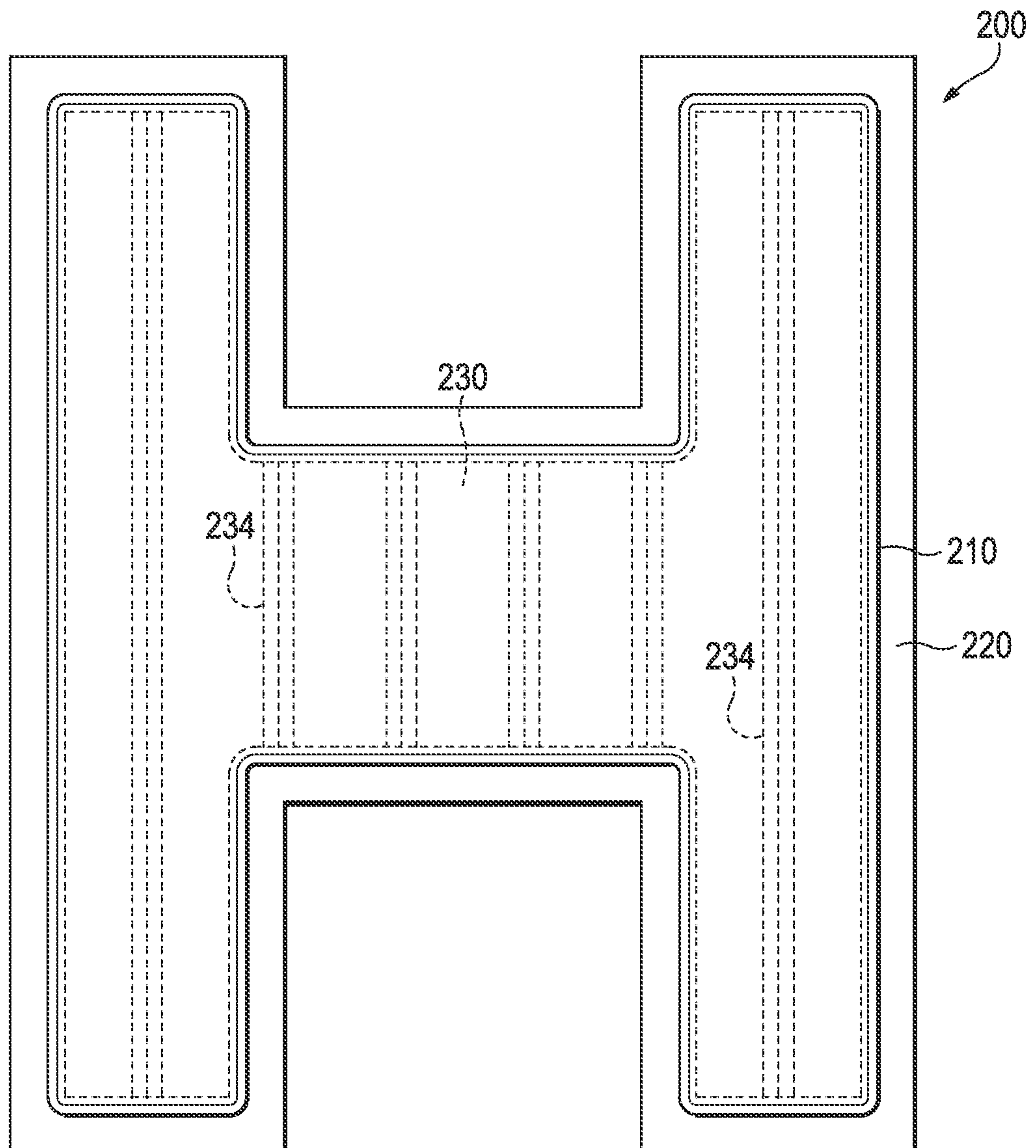
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**Figure 14C**

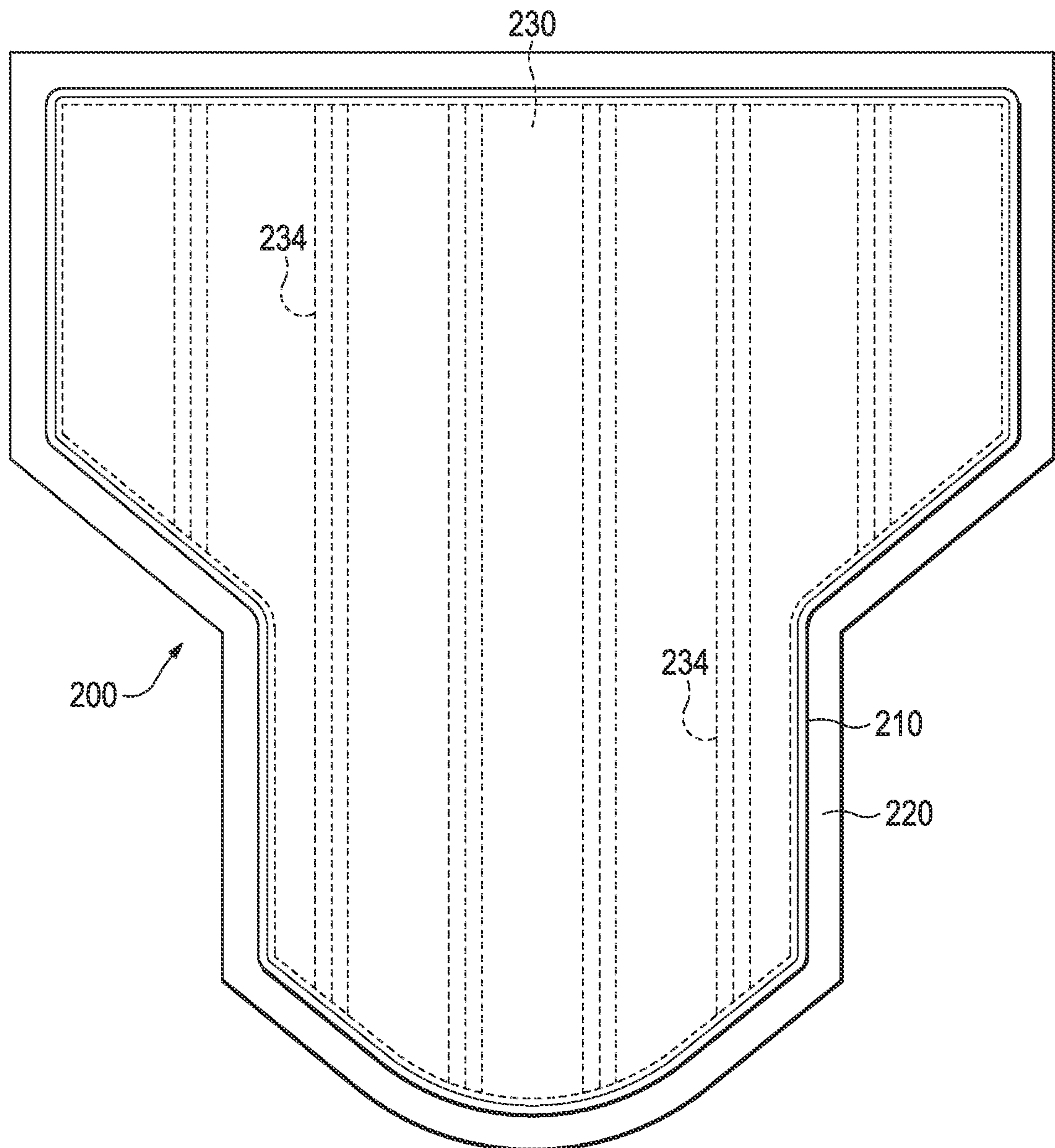
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**Figure 14D**

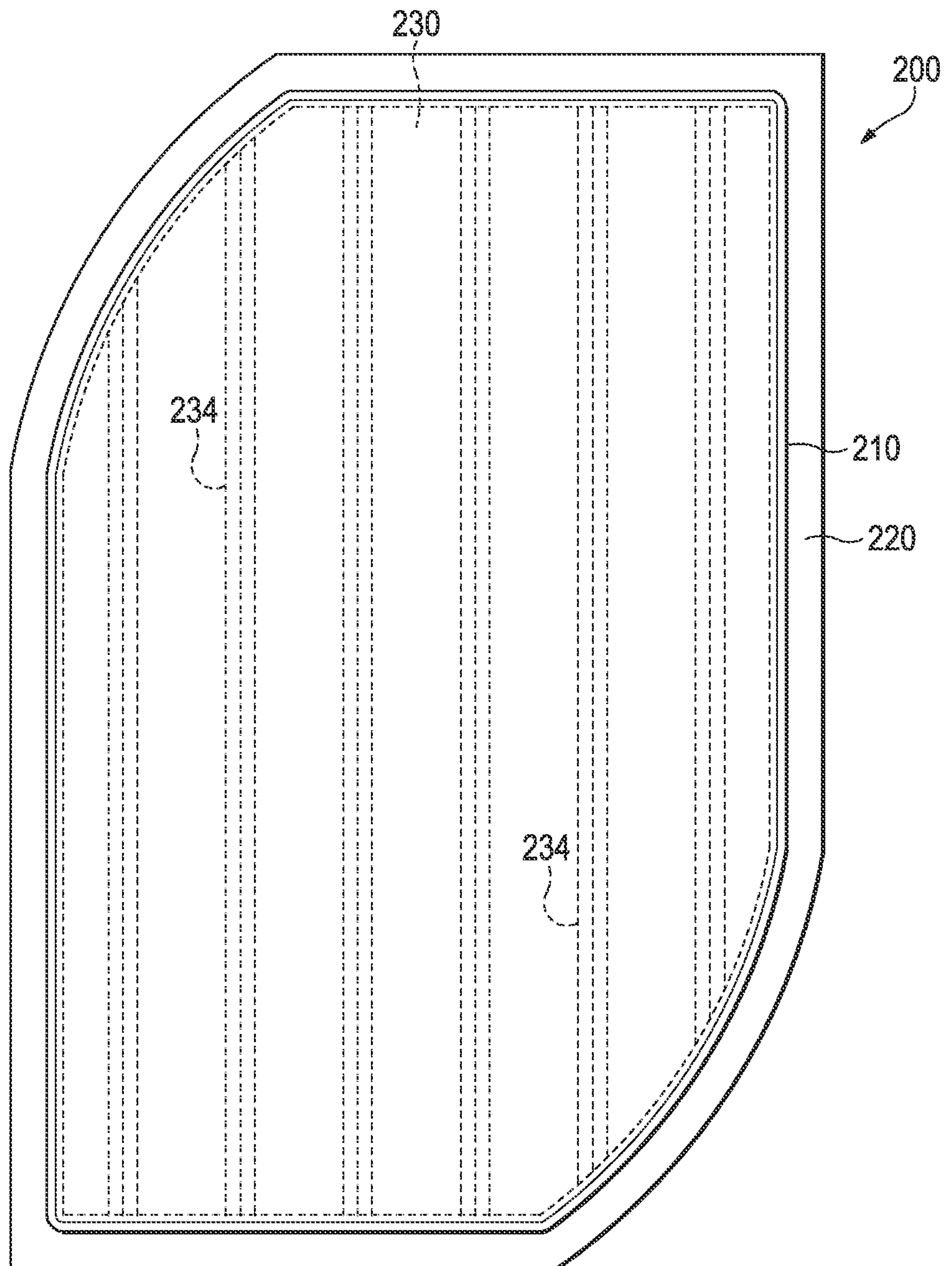
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**Figure 14E**

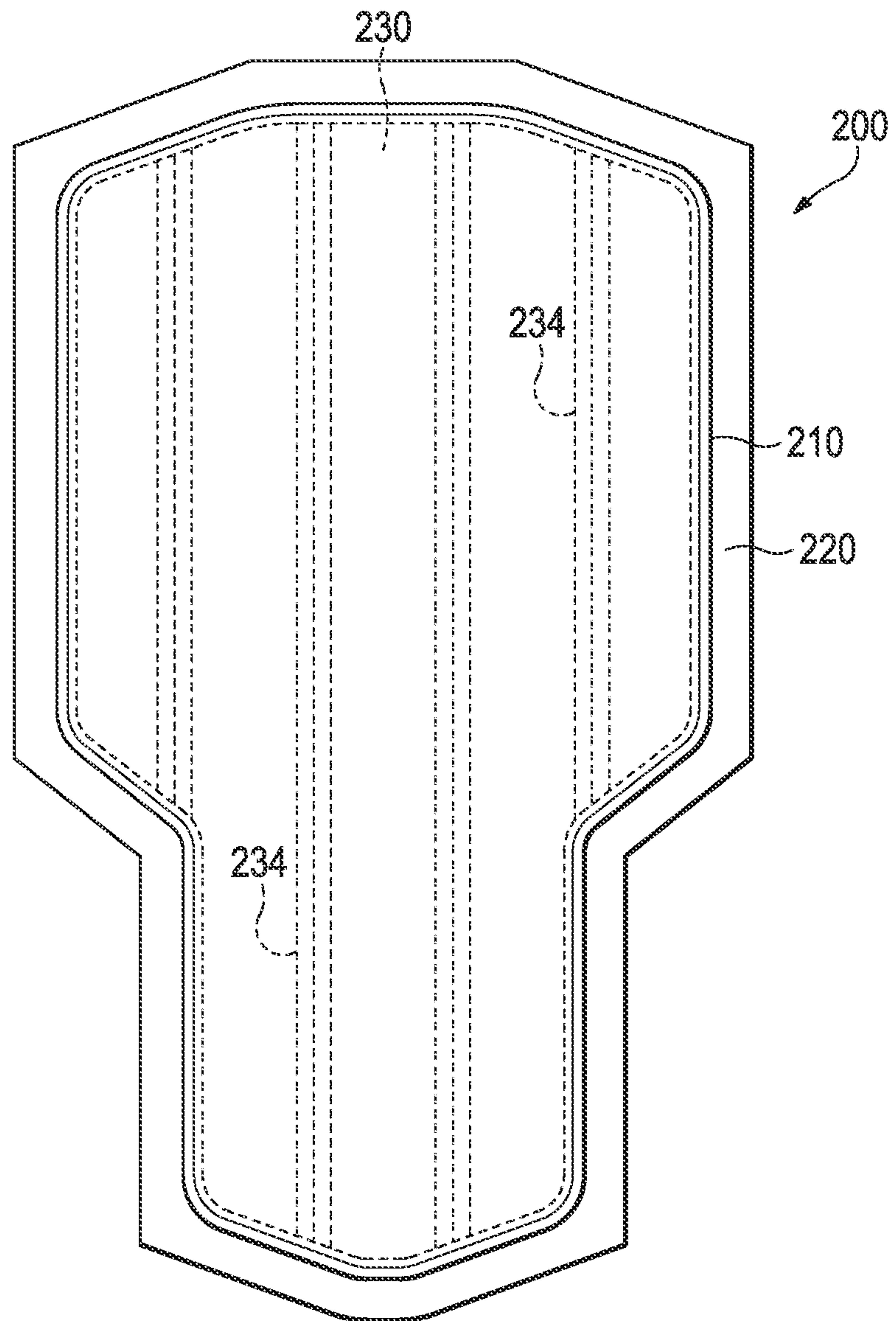
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**Figure 14F**

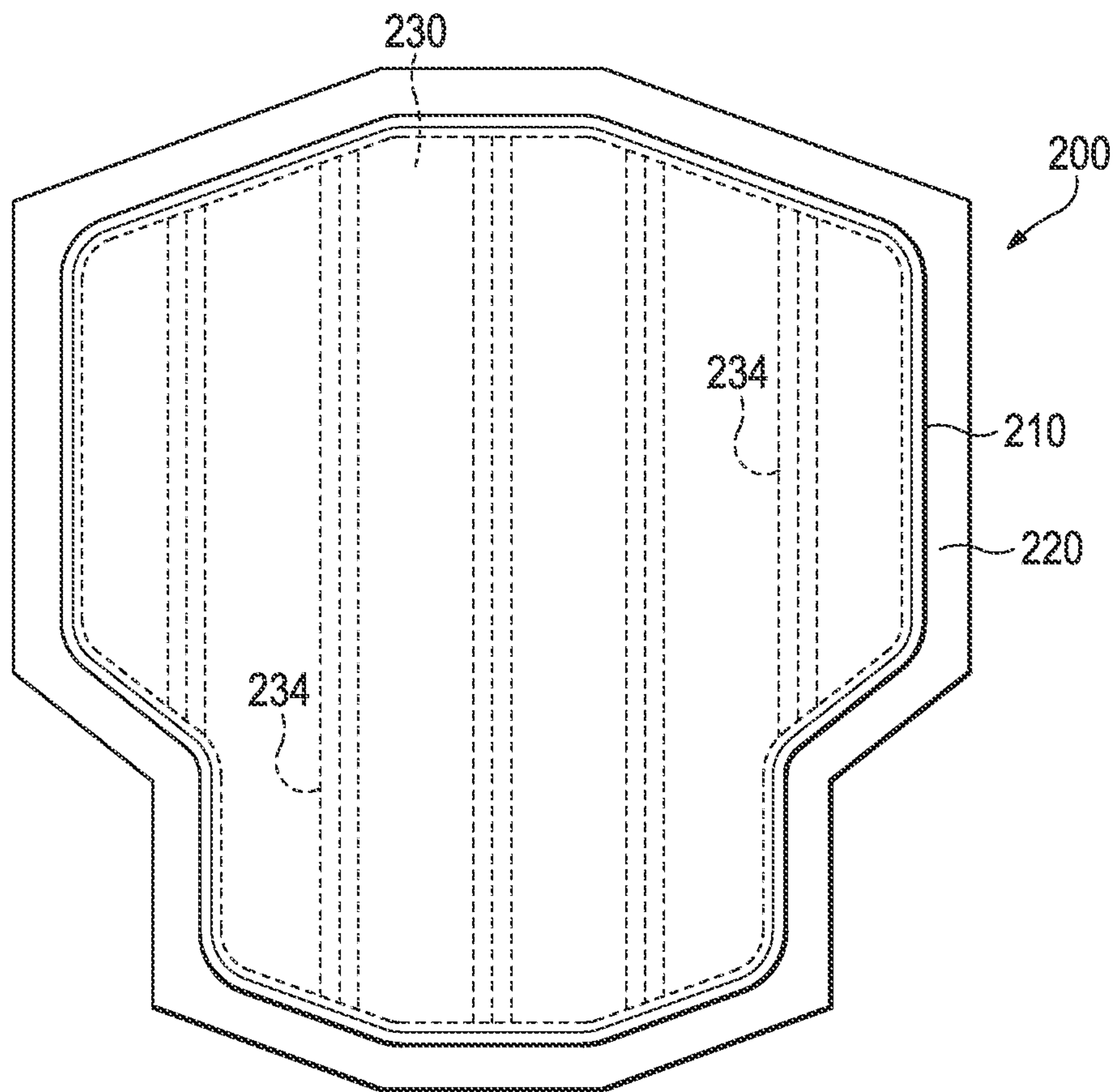
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**Figure 14G**

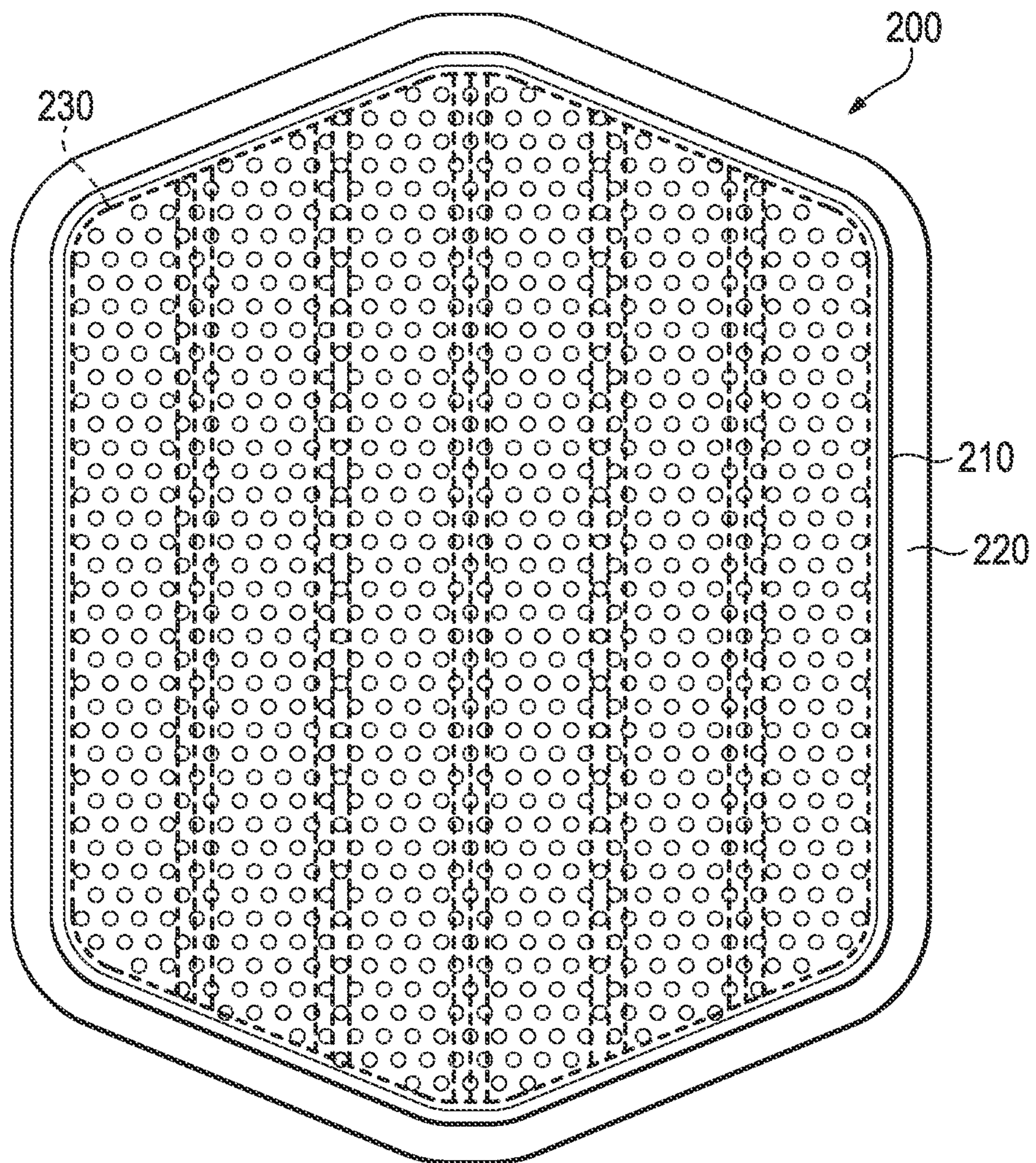
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**Figure 14H**

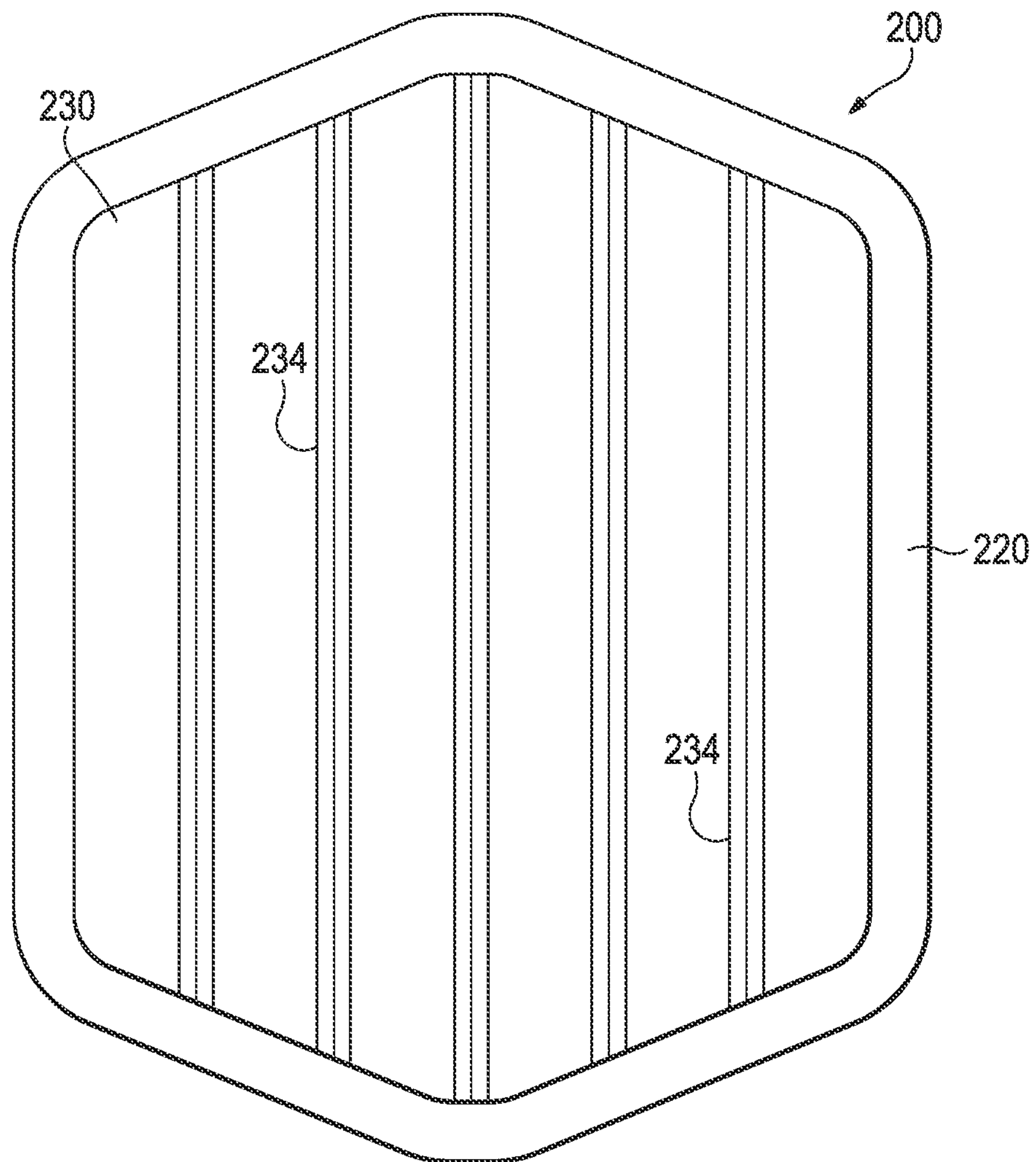
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**Figure 14I**

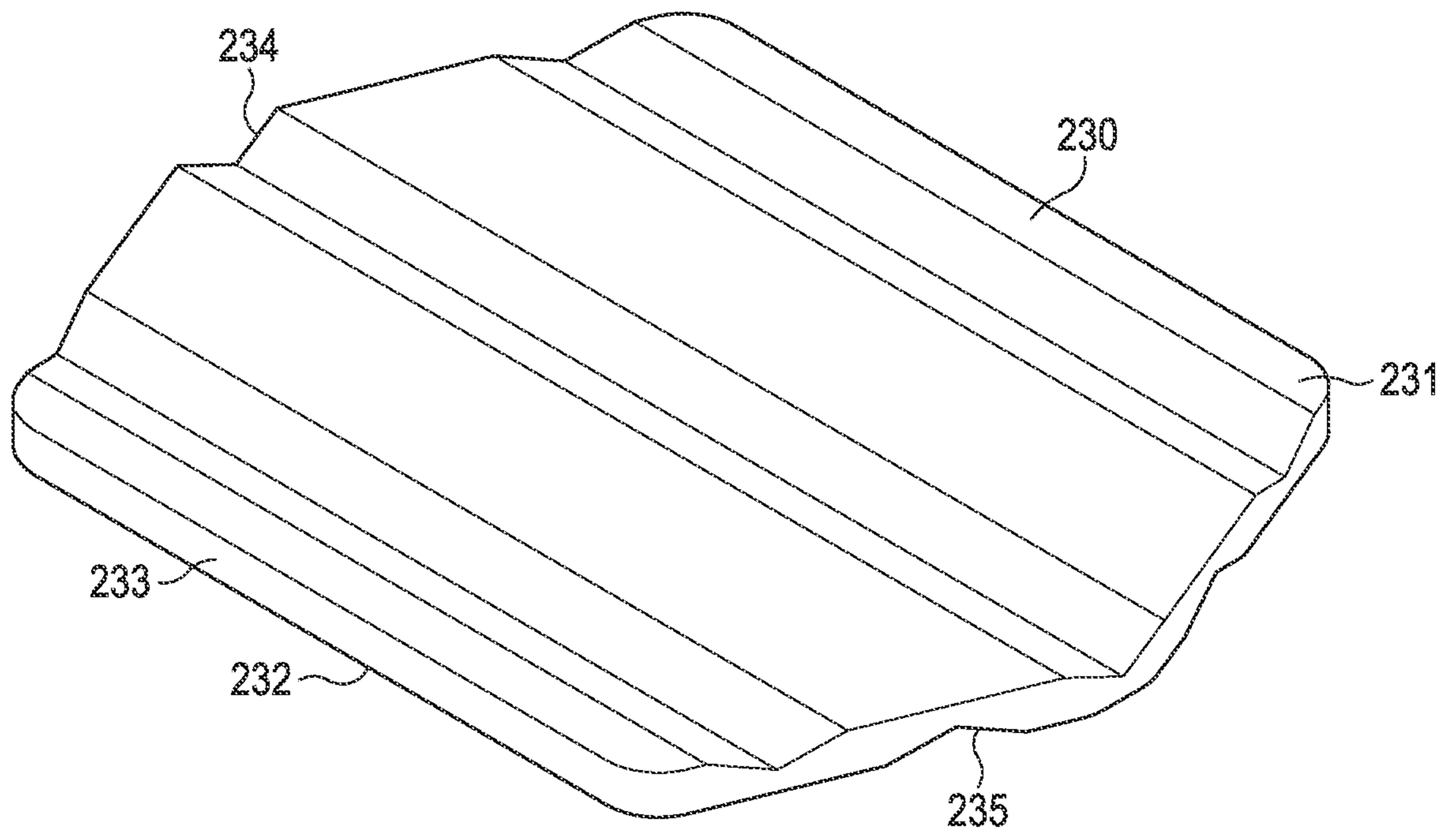
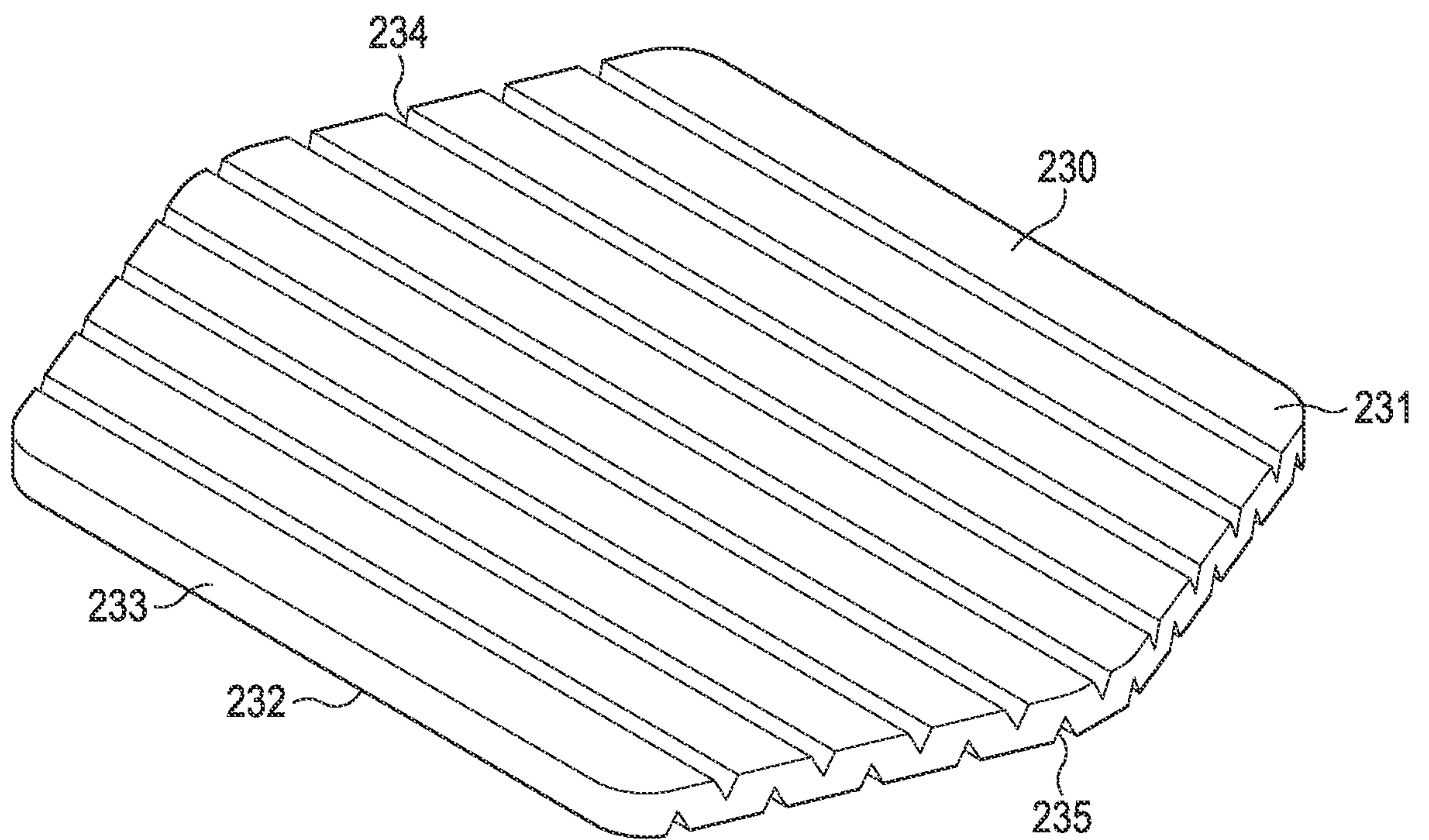
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**Figure 14J**

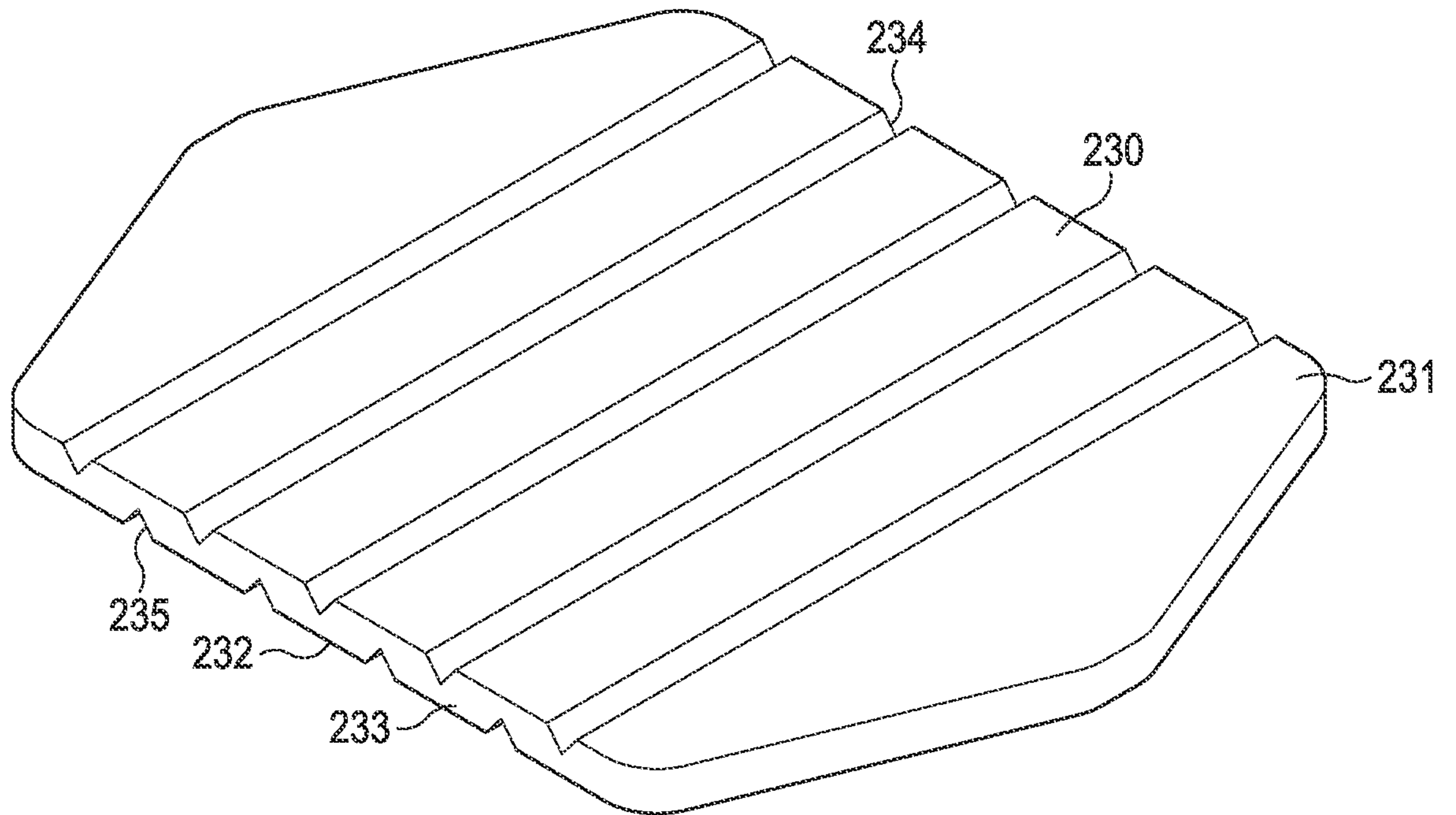
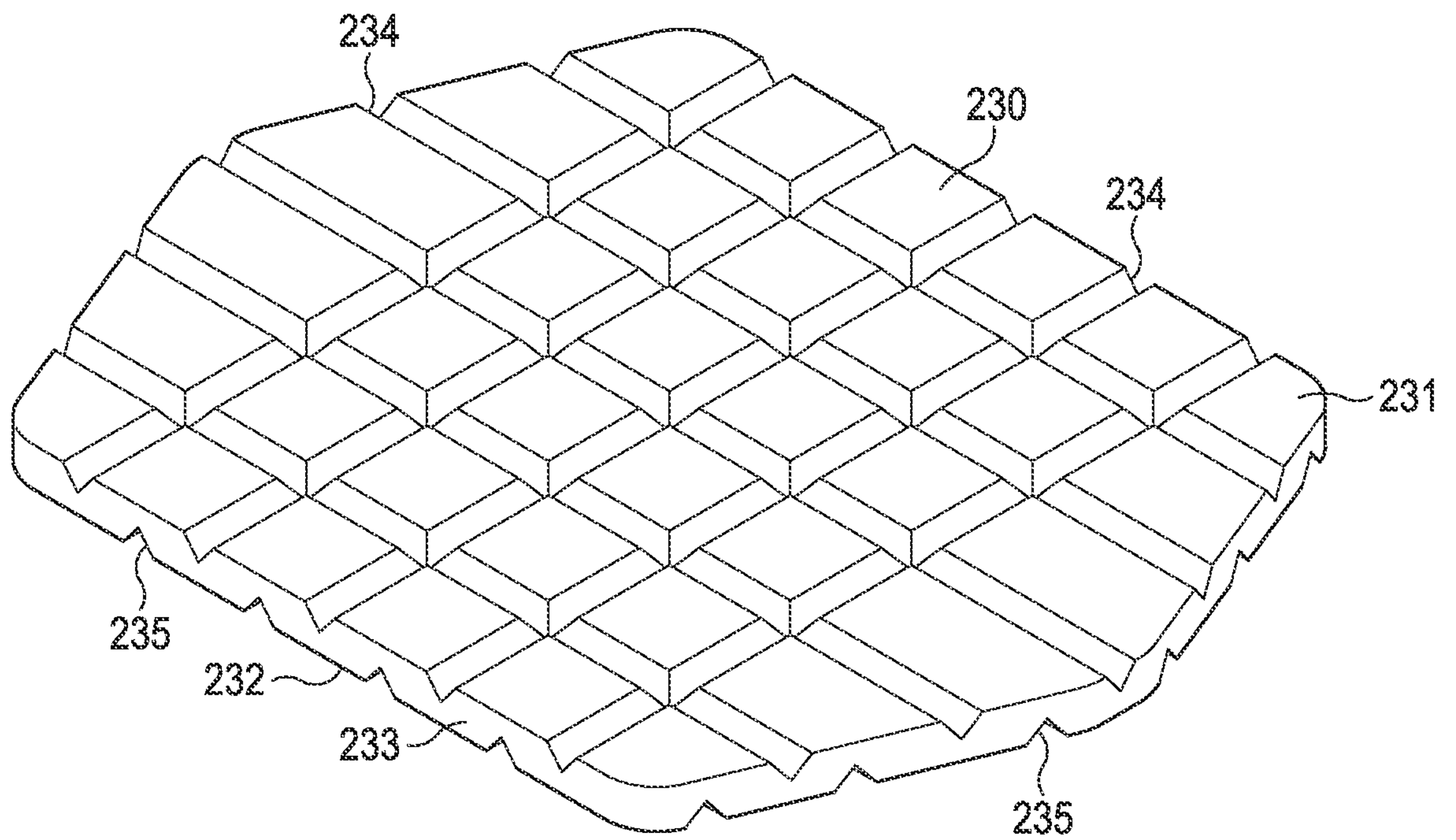
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**Figure 14K**

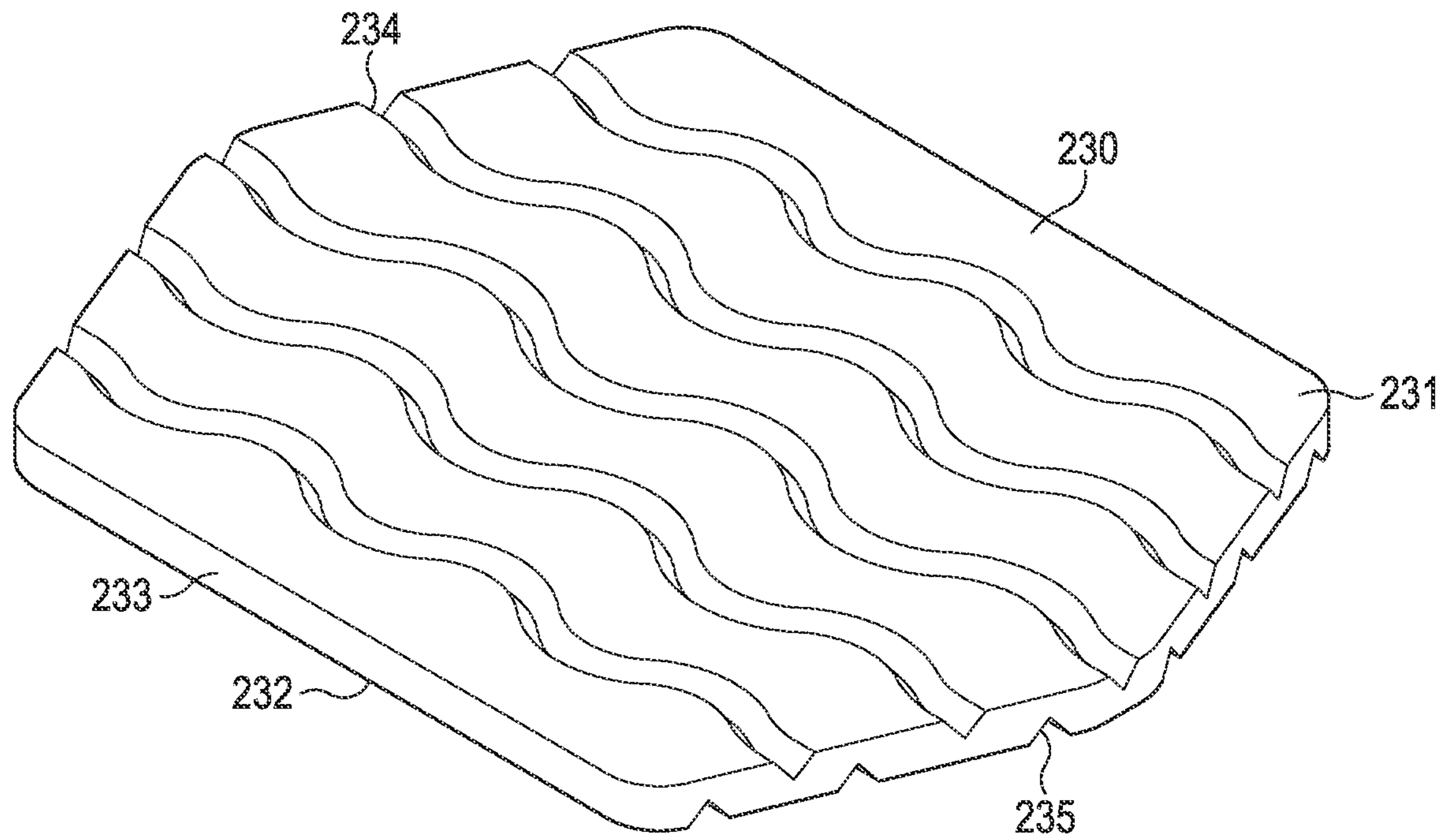
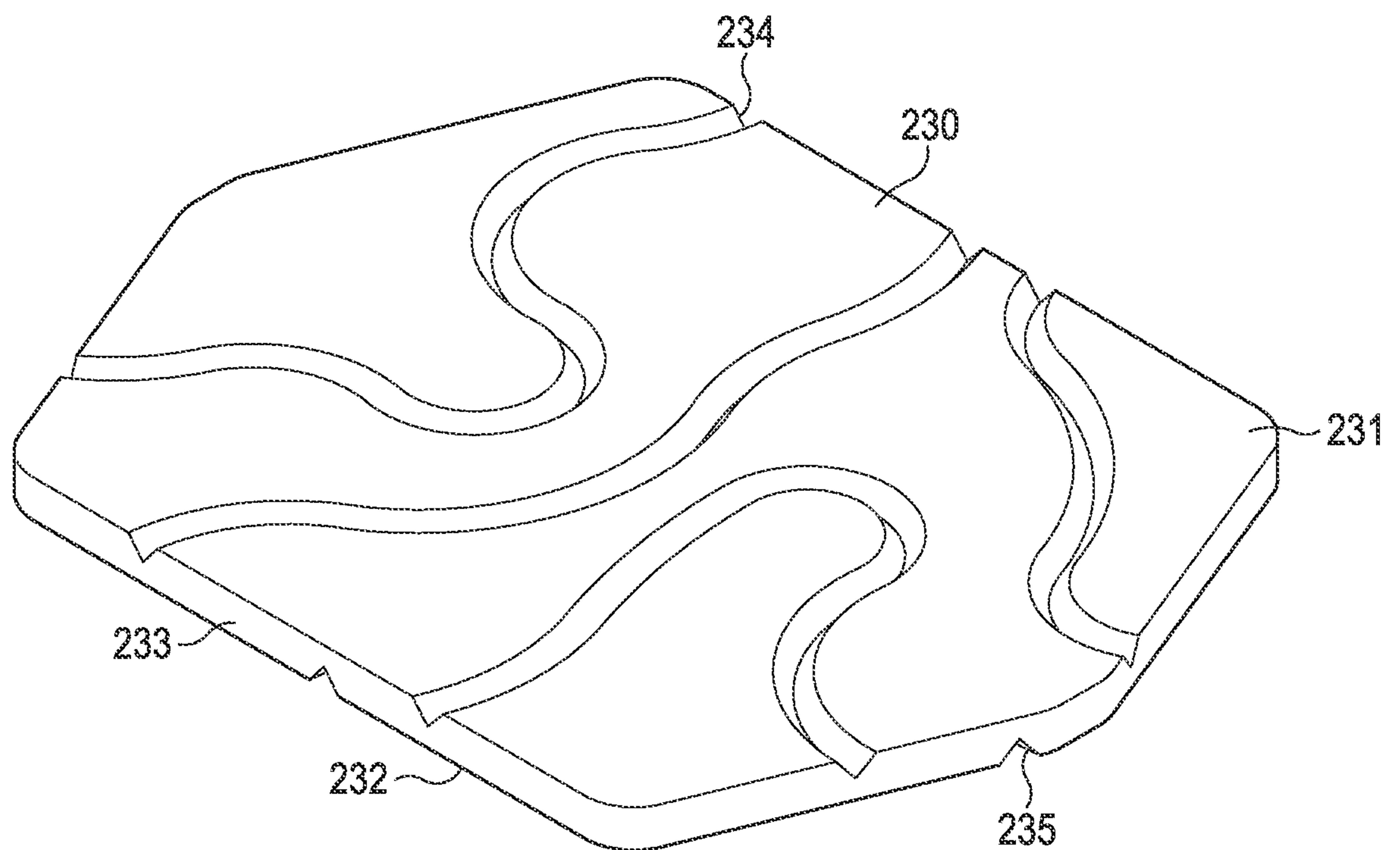
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**Figure 15A****Figure 15B**

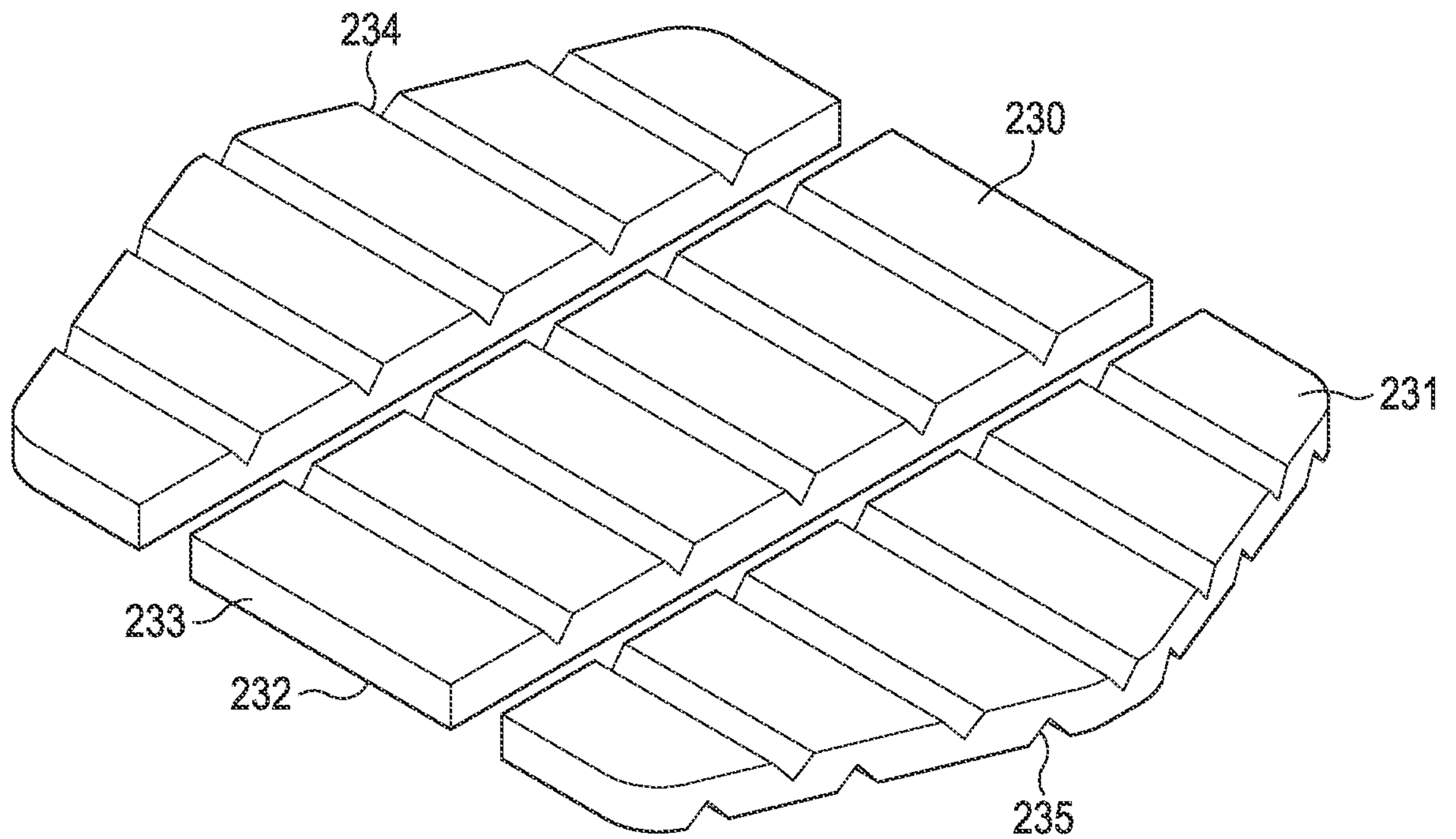
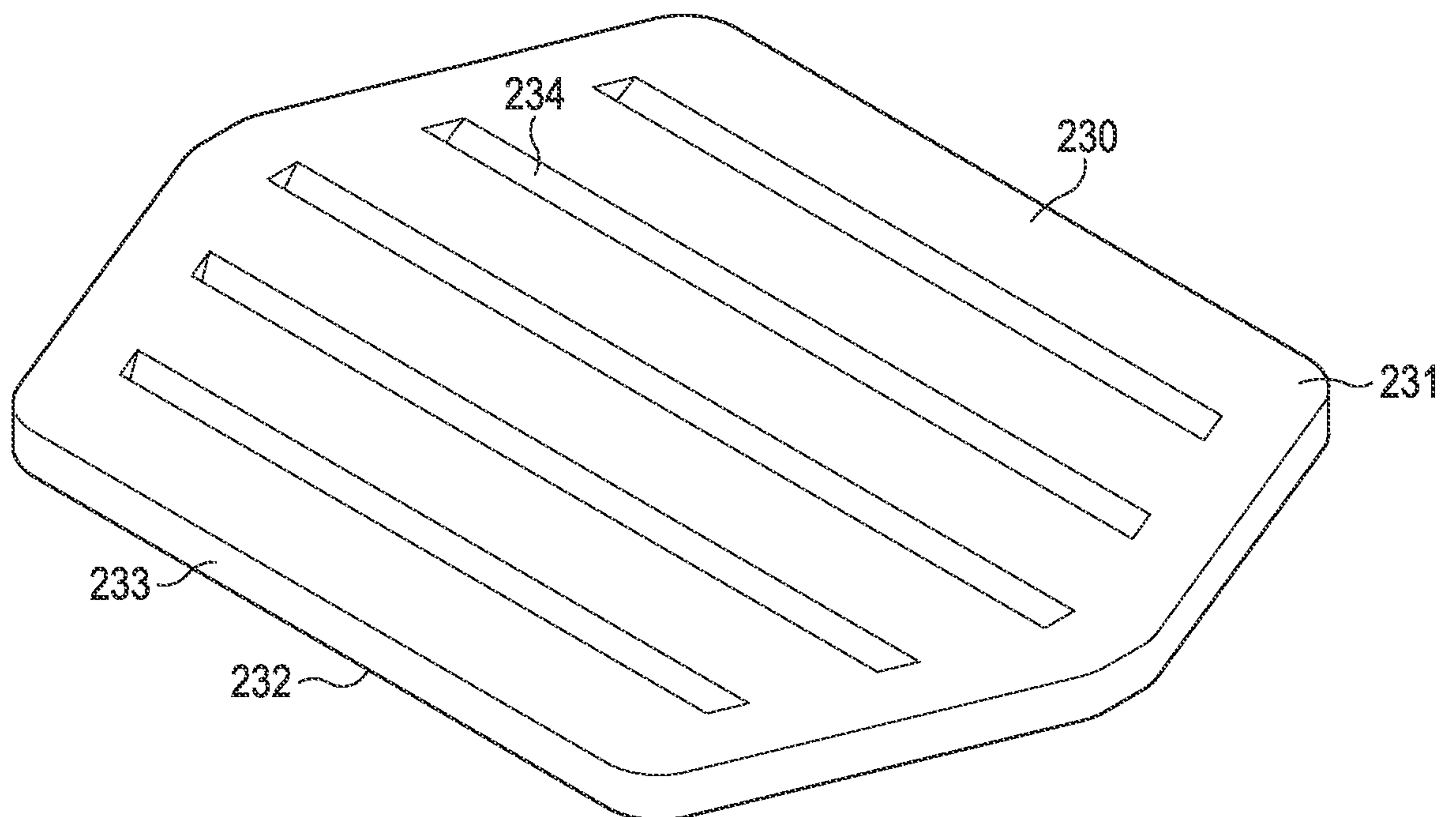
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**Figure 15C****Figure 15D**

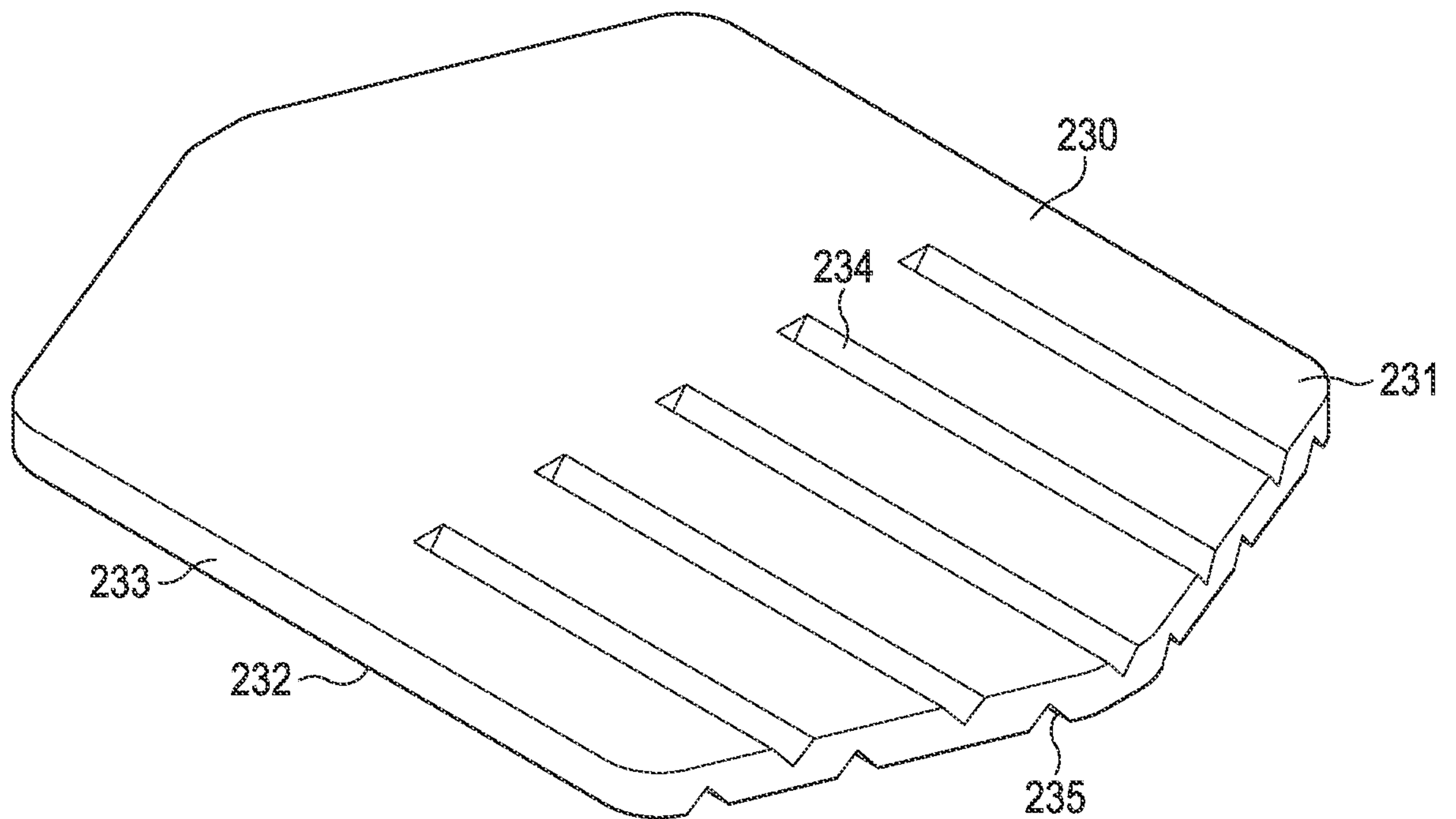
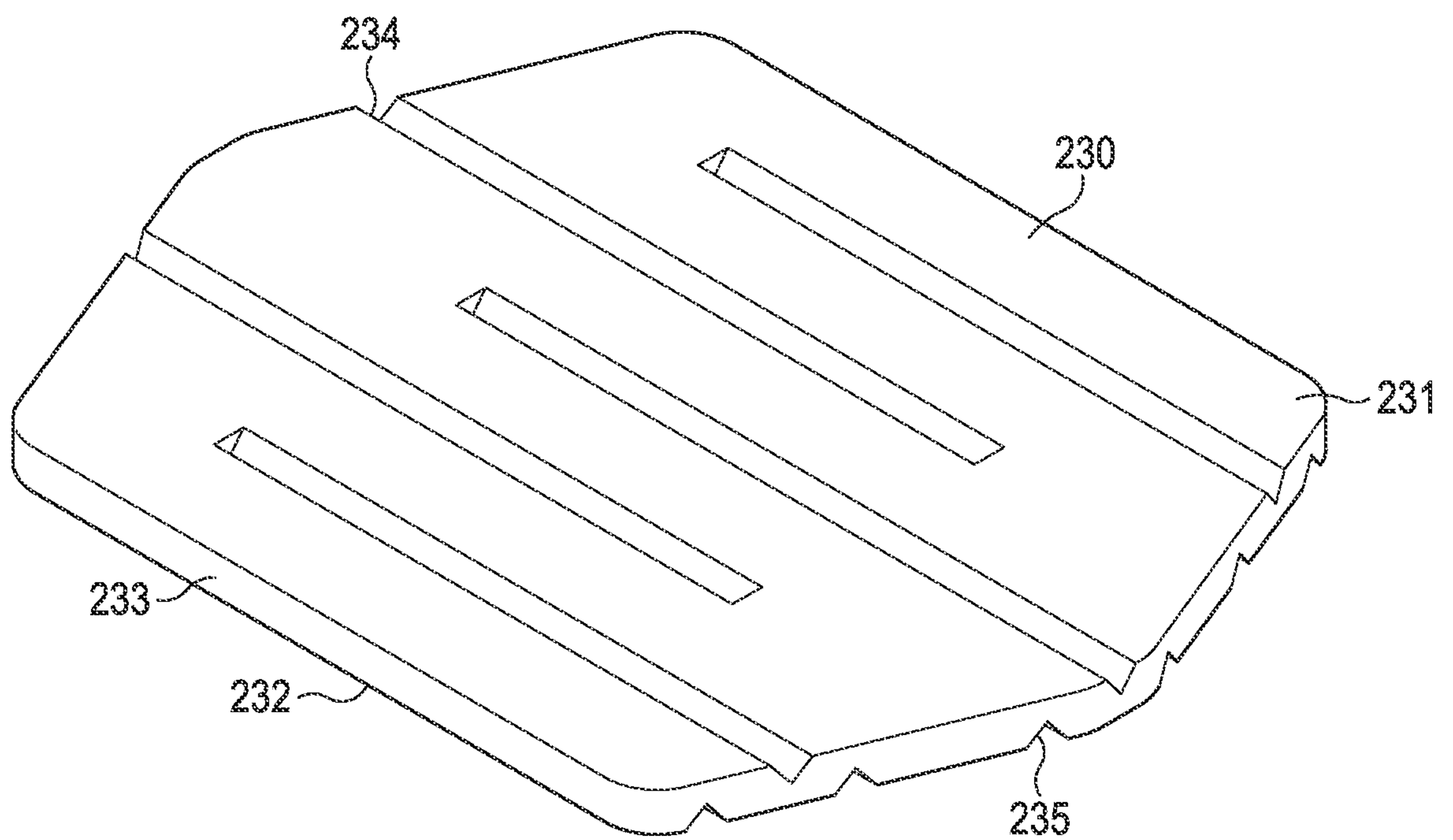
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**Figure 15E****Figure 15F**

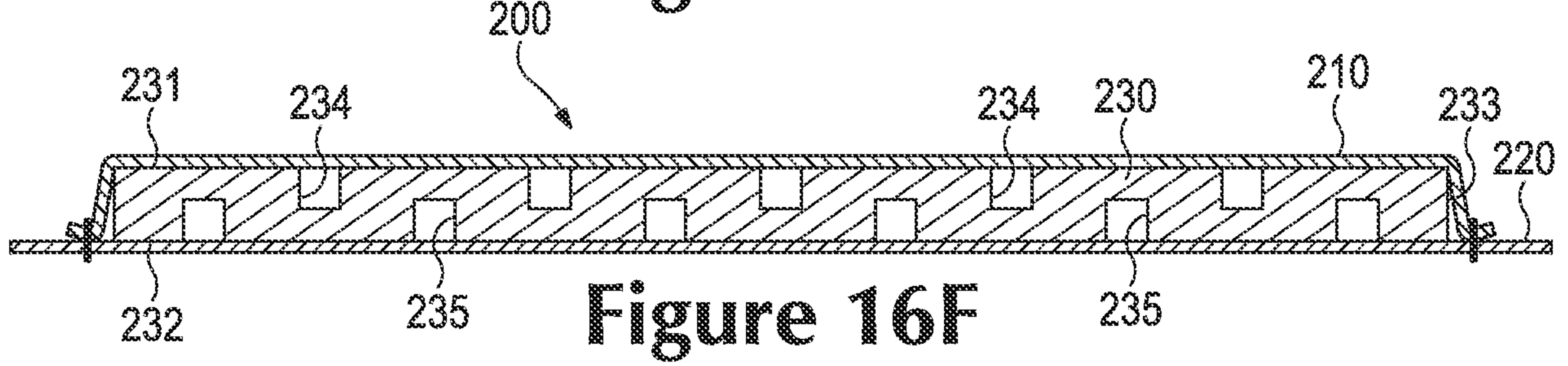
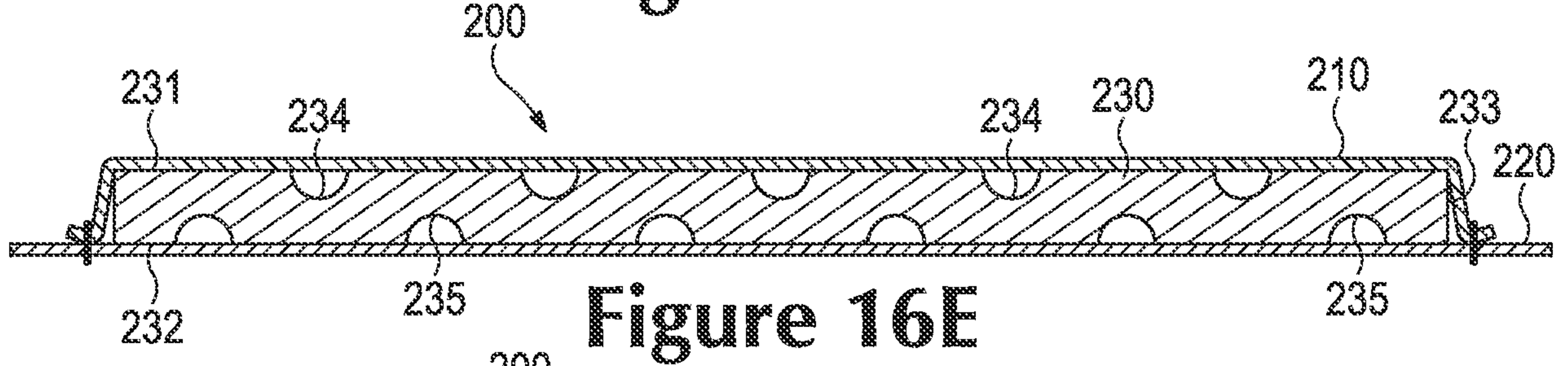
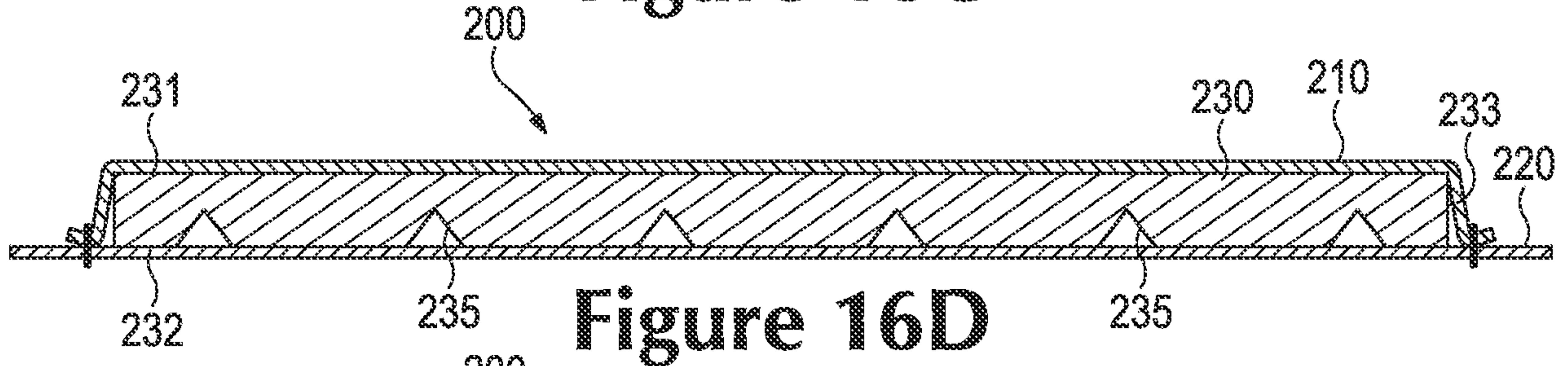
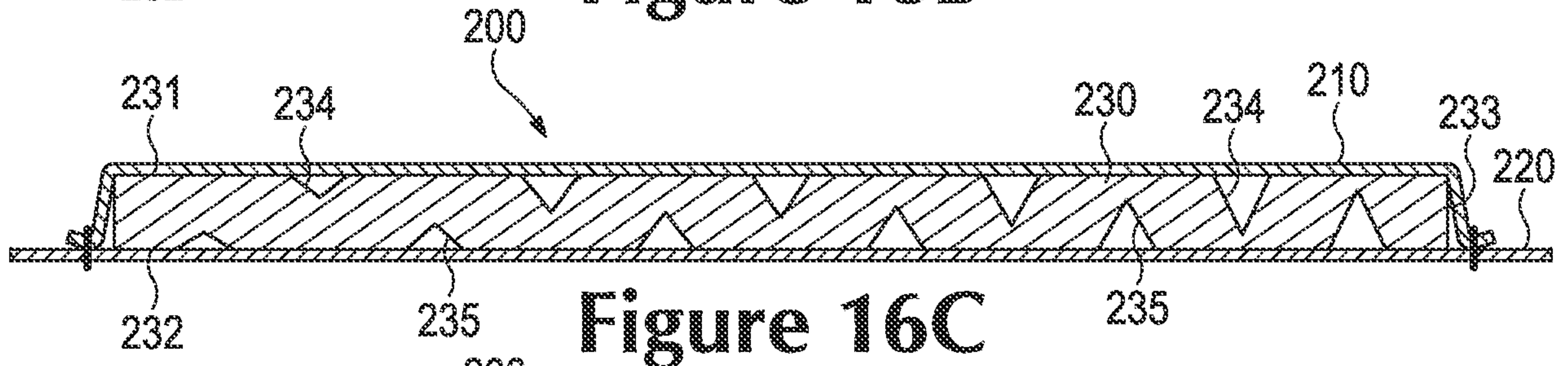
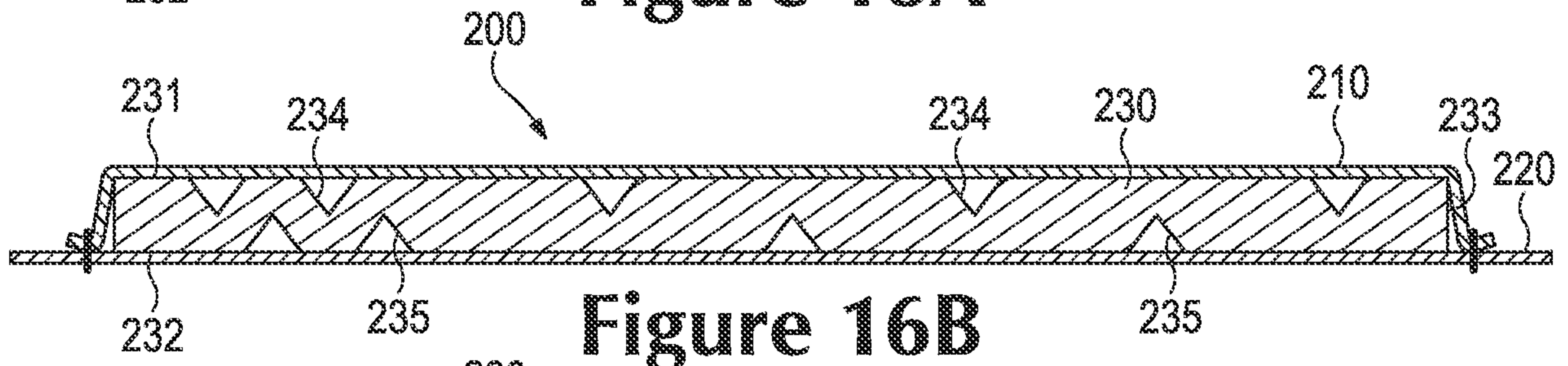
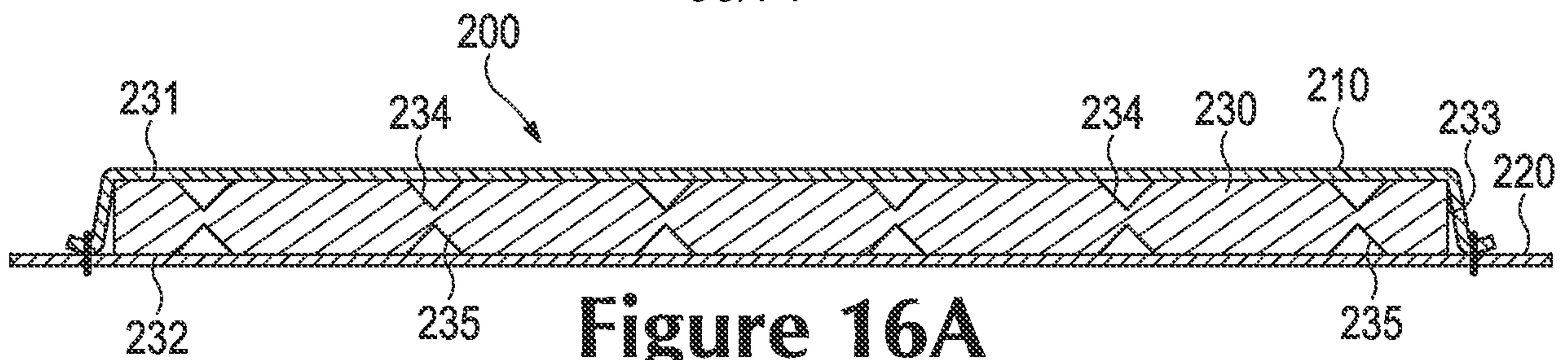
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**Figure 15G****Figure 15H**

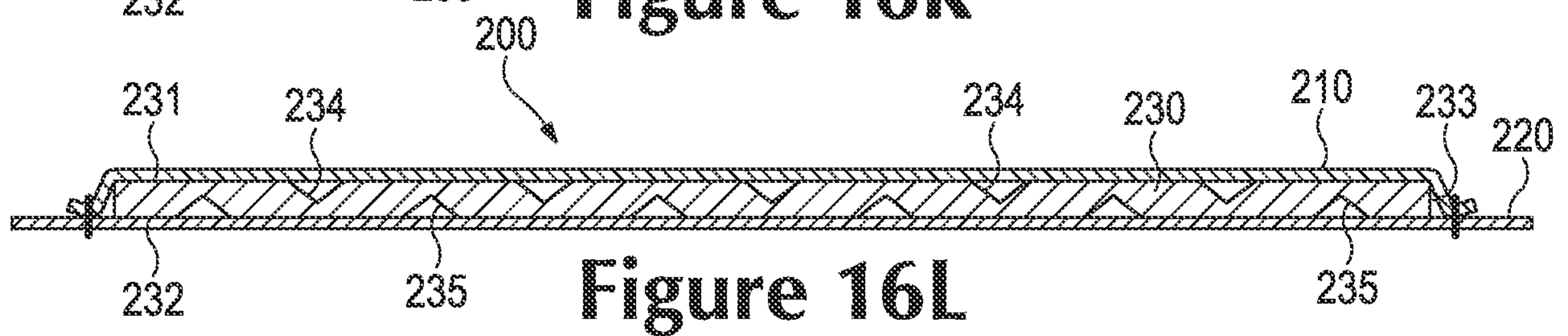
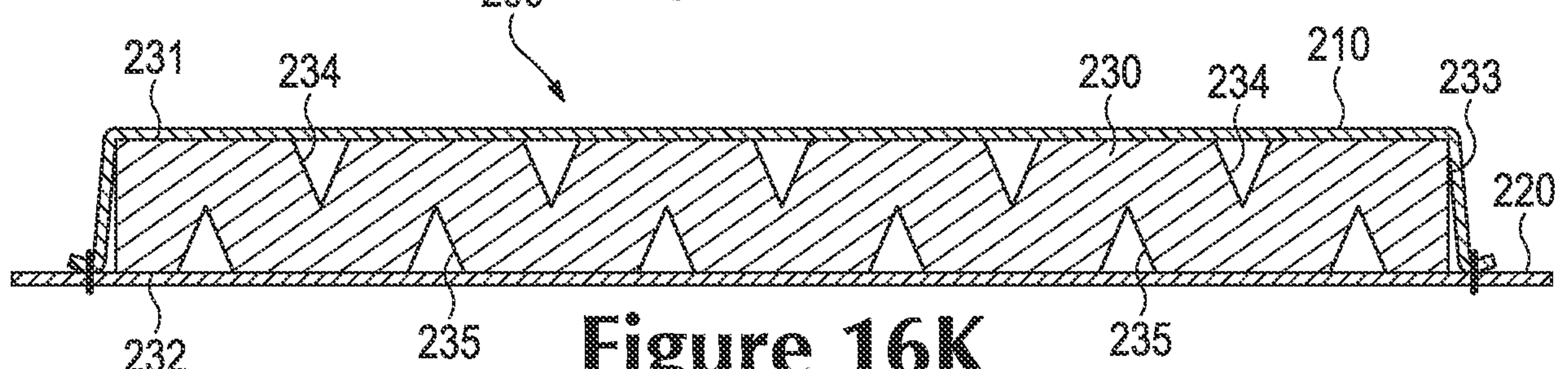
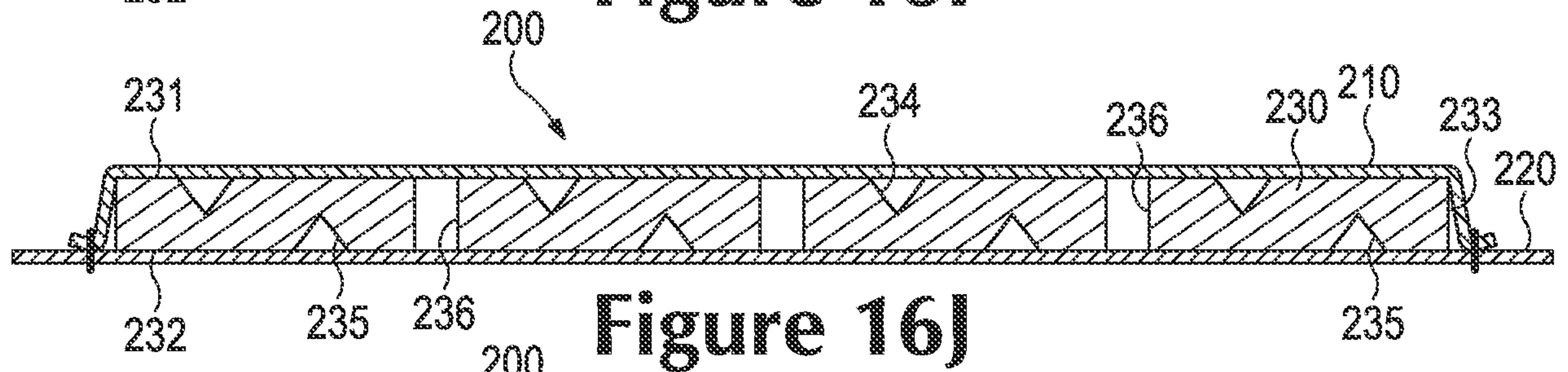
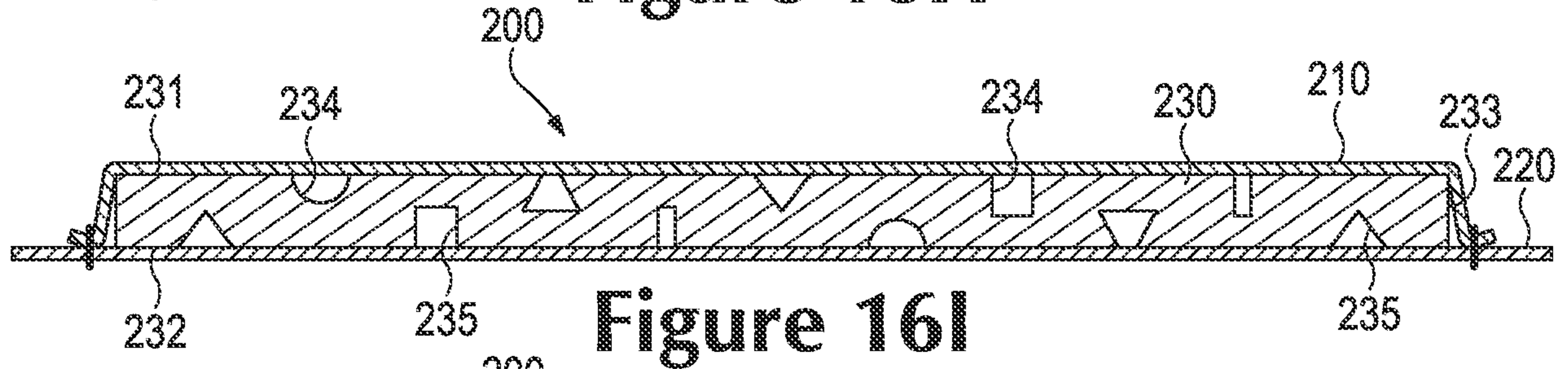
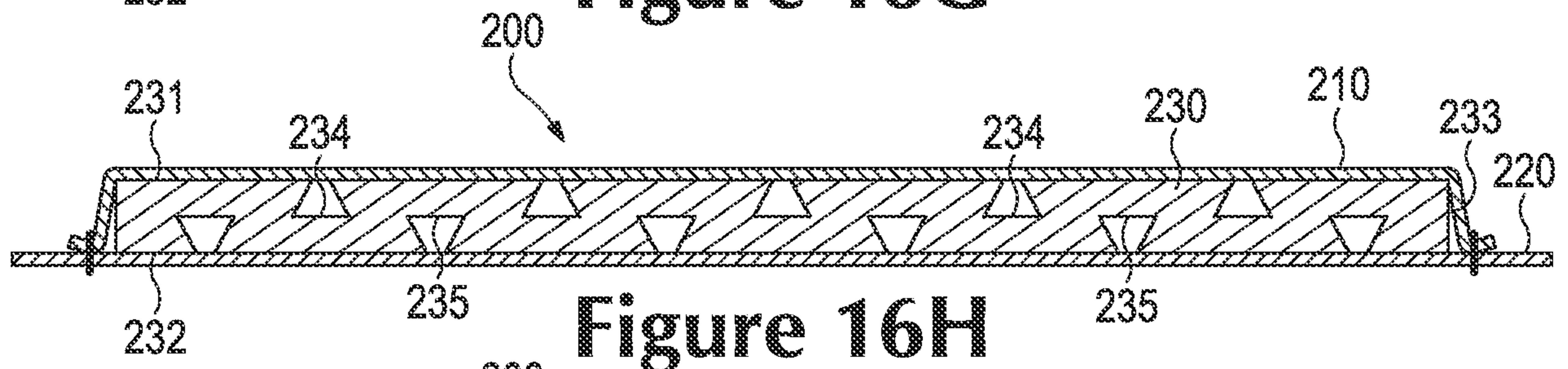
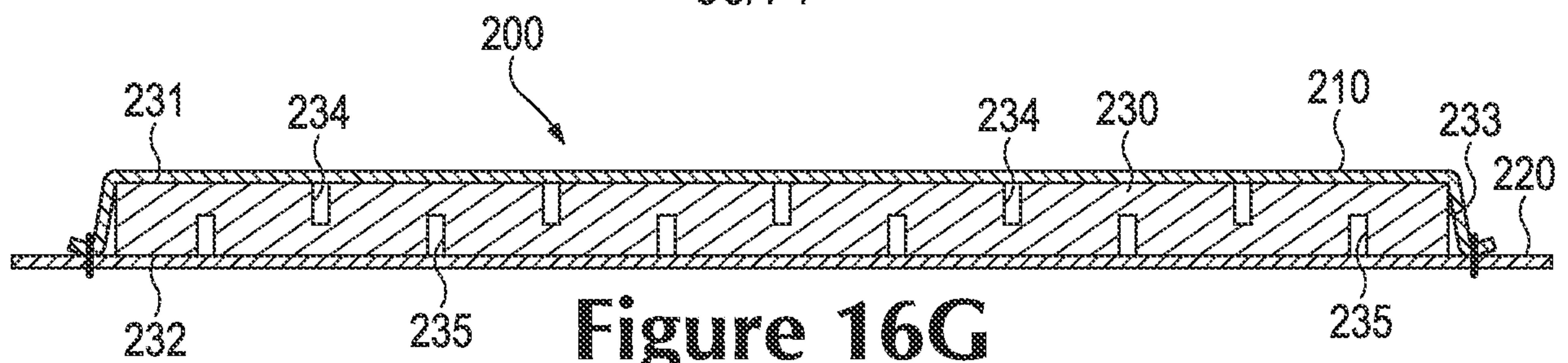
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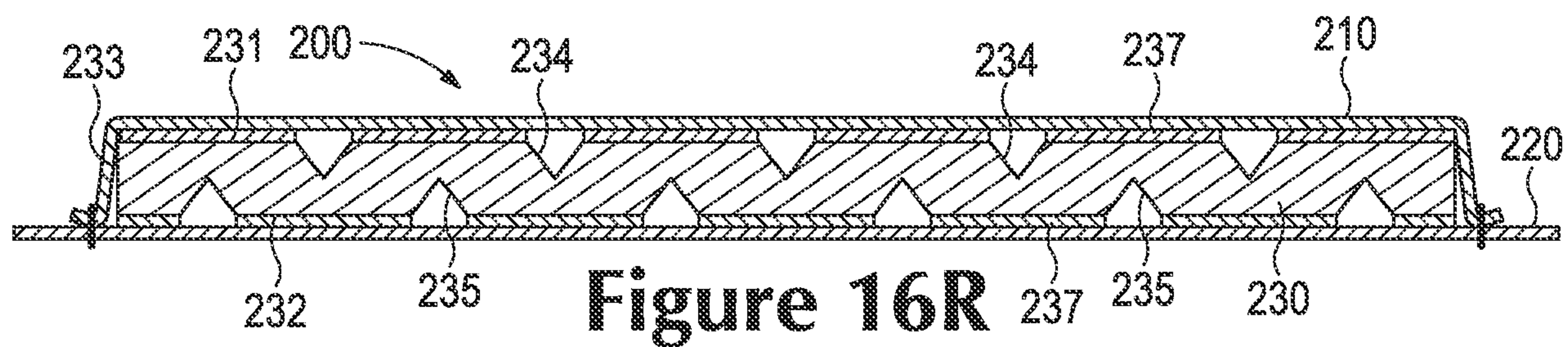
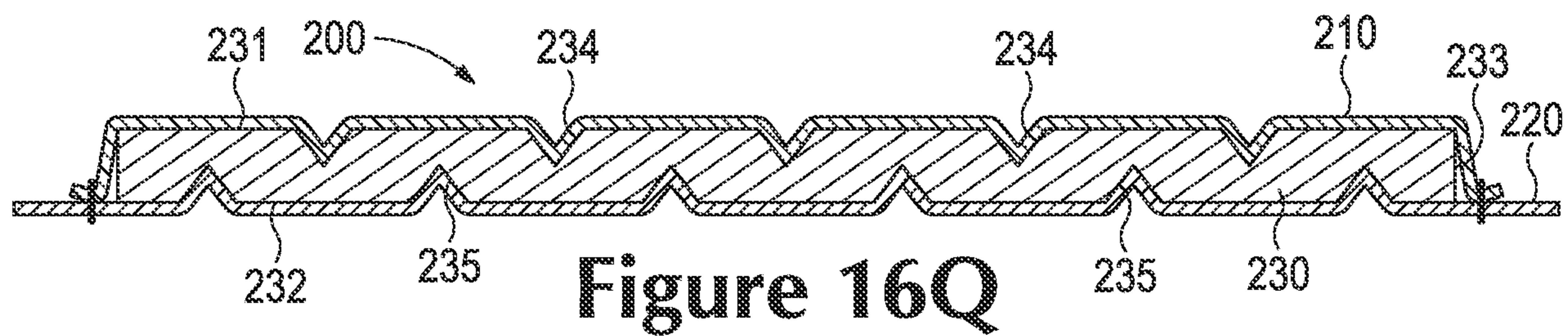
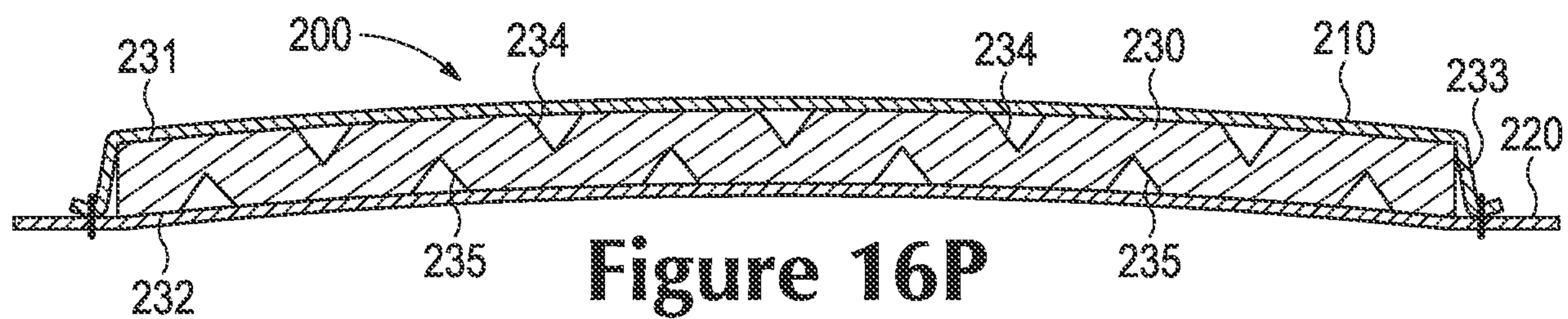
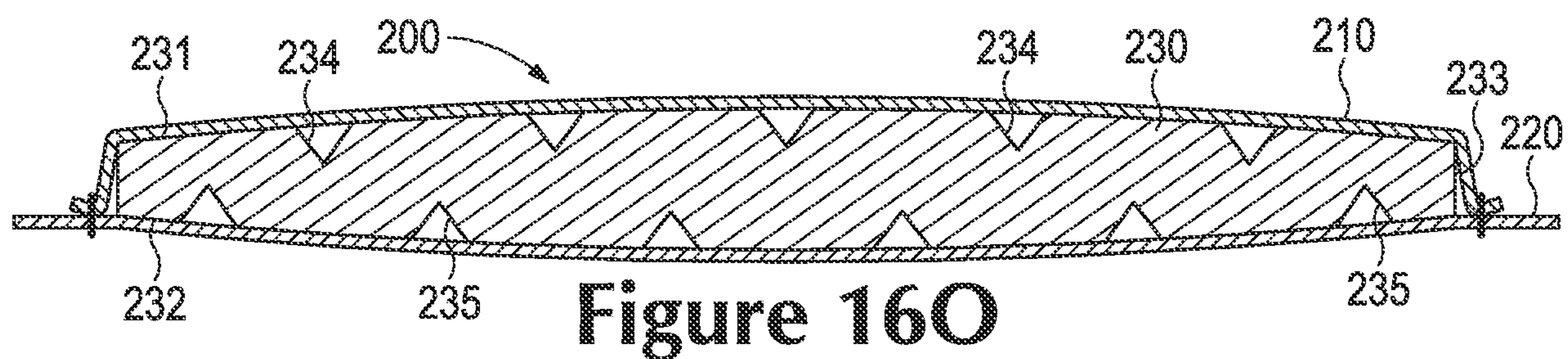
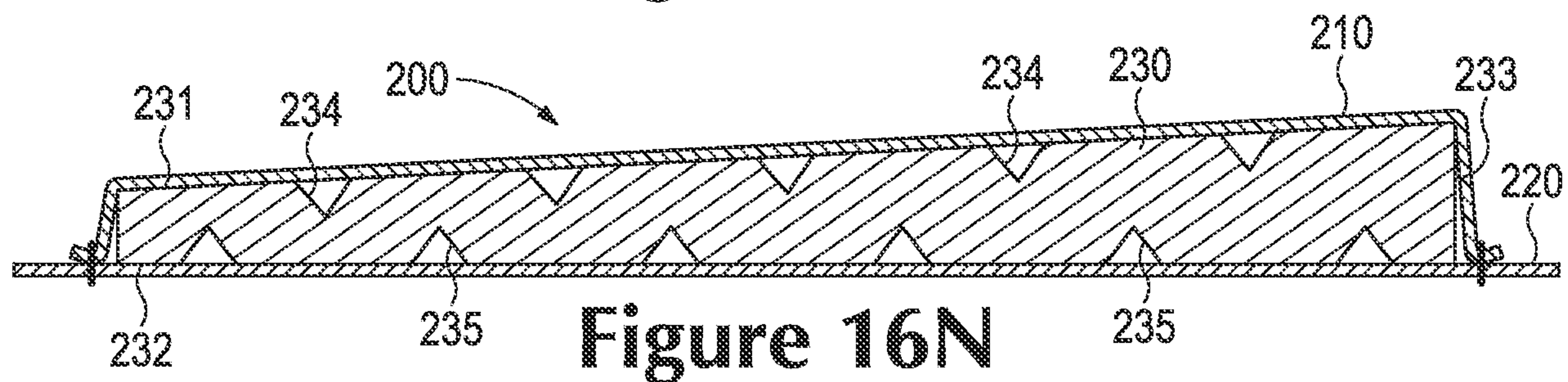
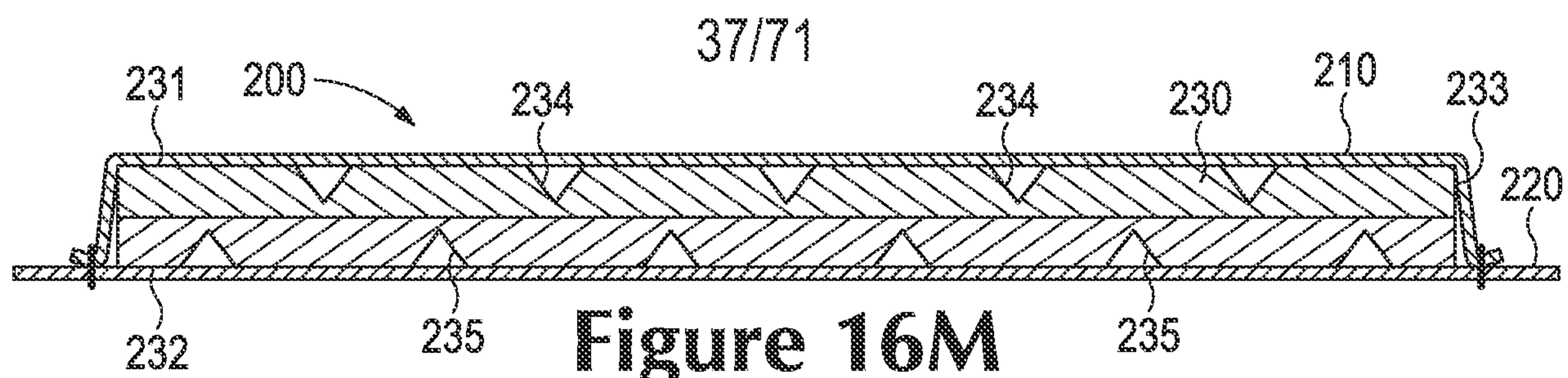
**Figure 15I****Figure 15J**

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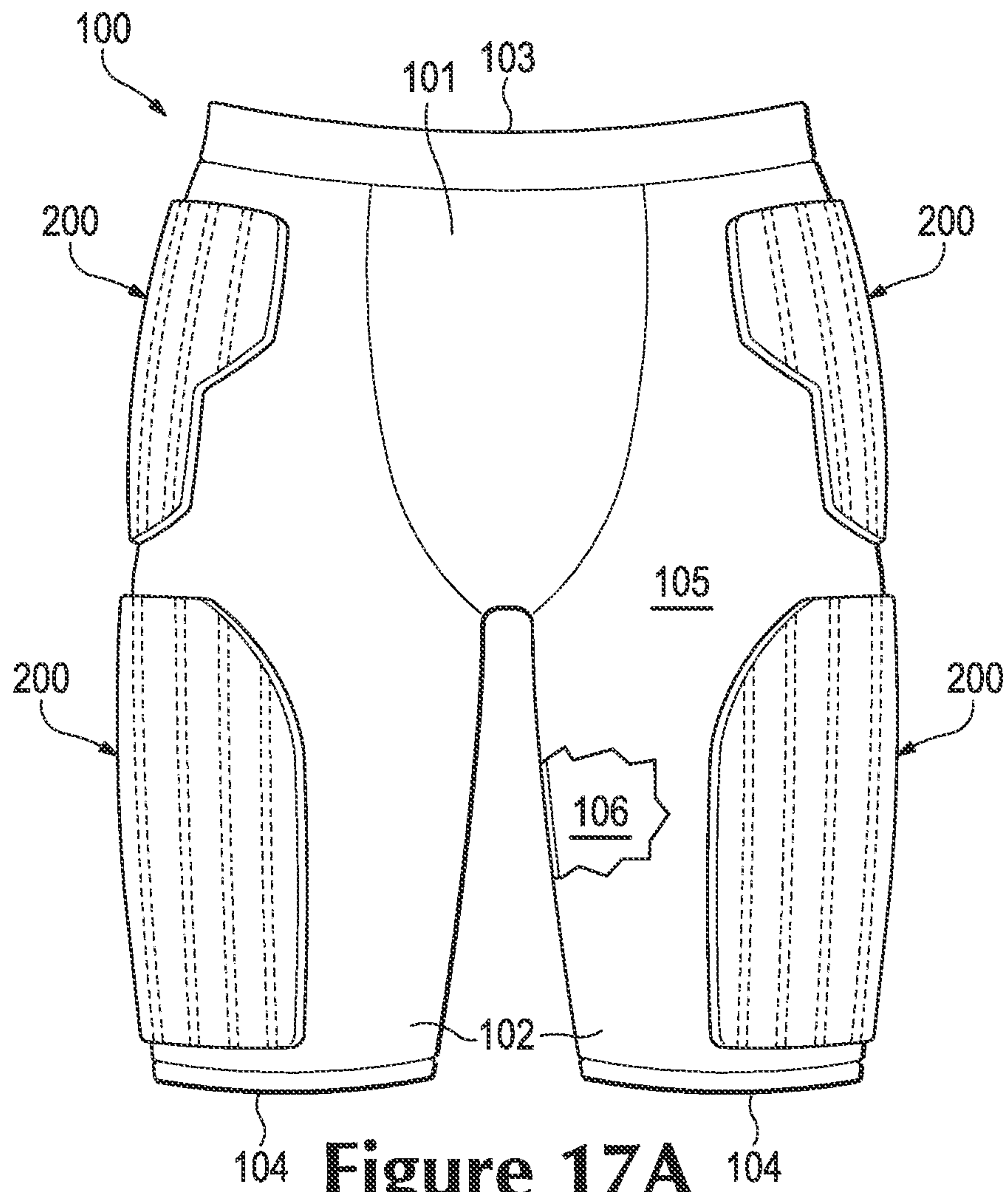


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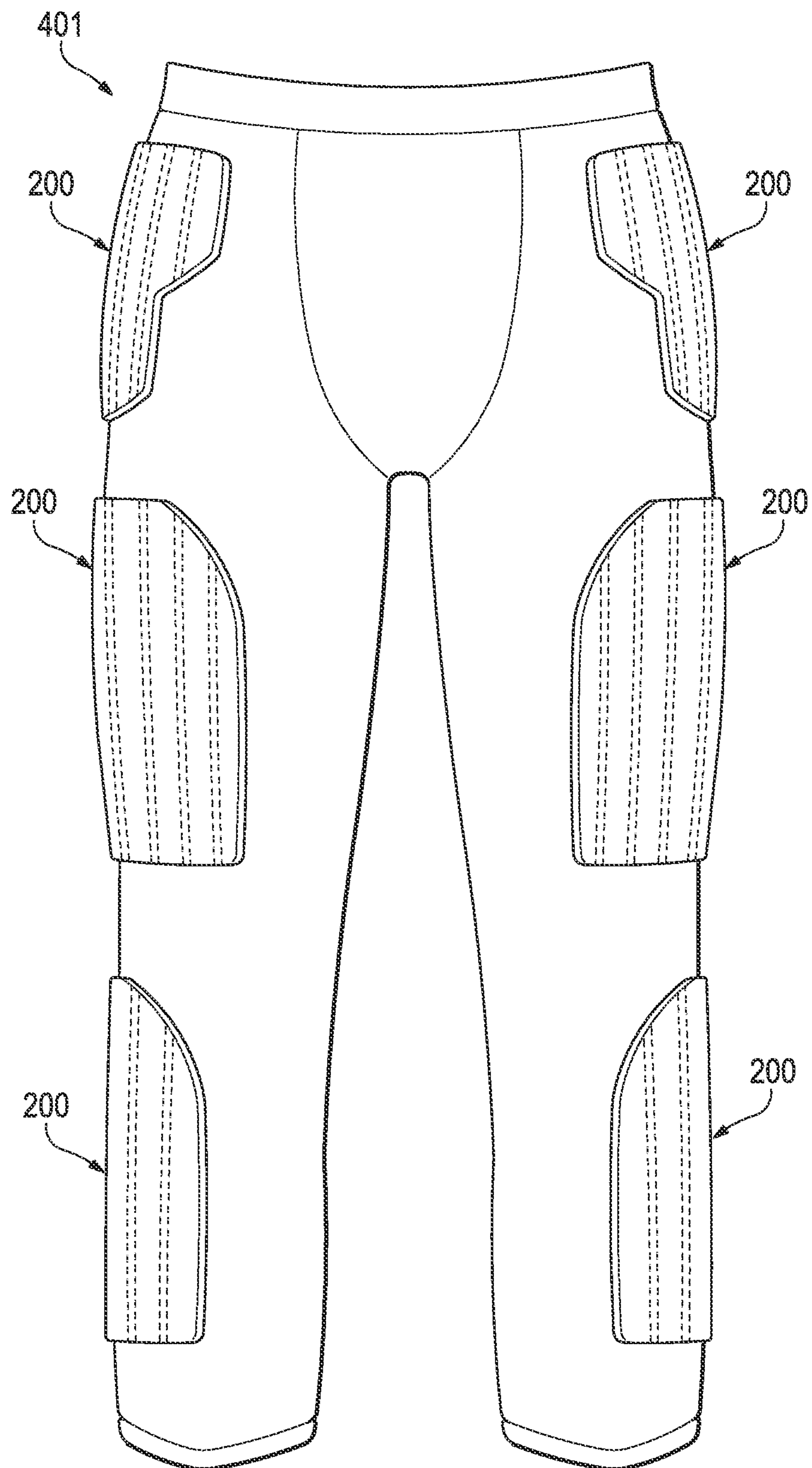




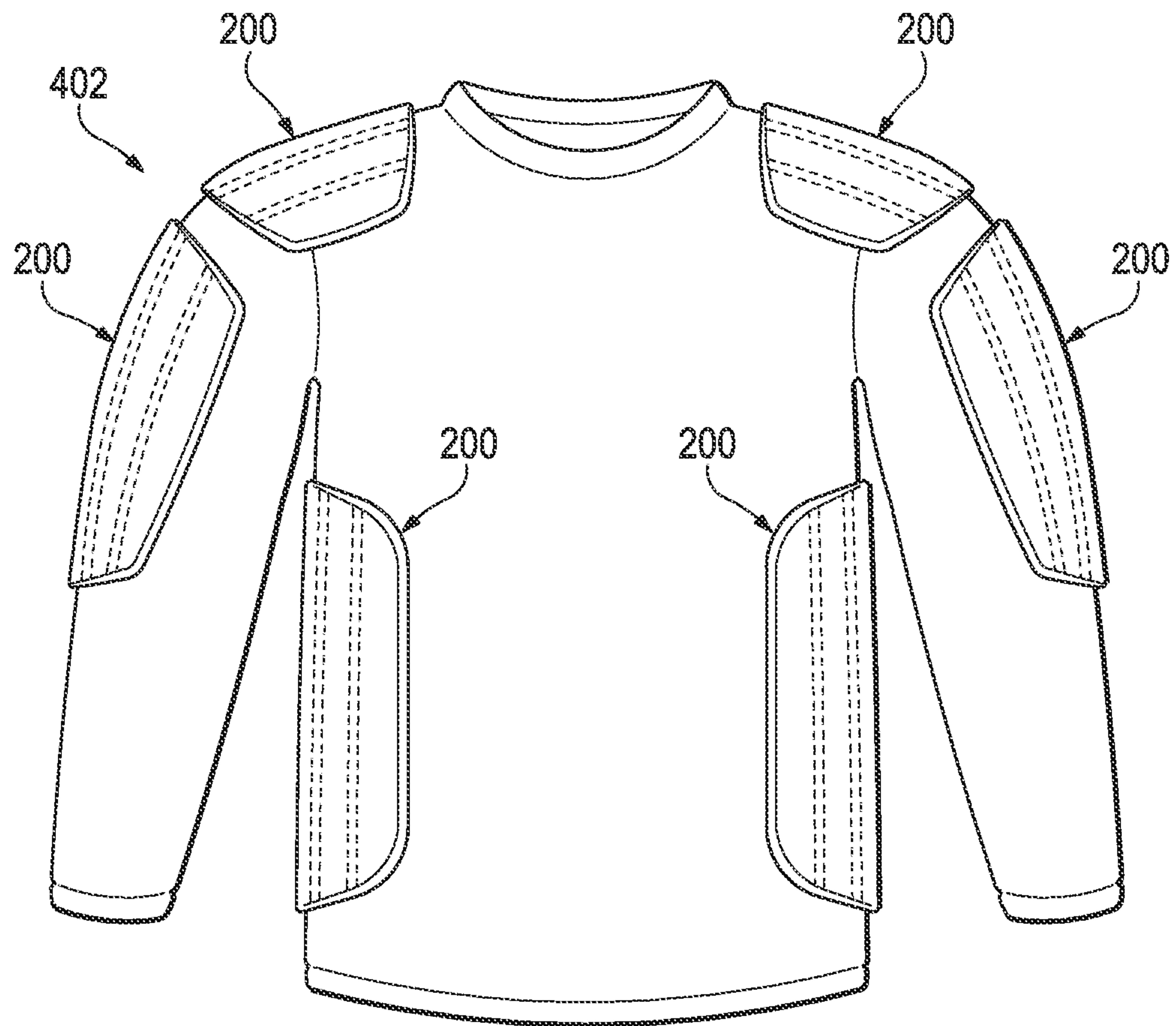
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**Figure 17A**

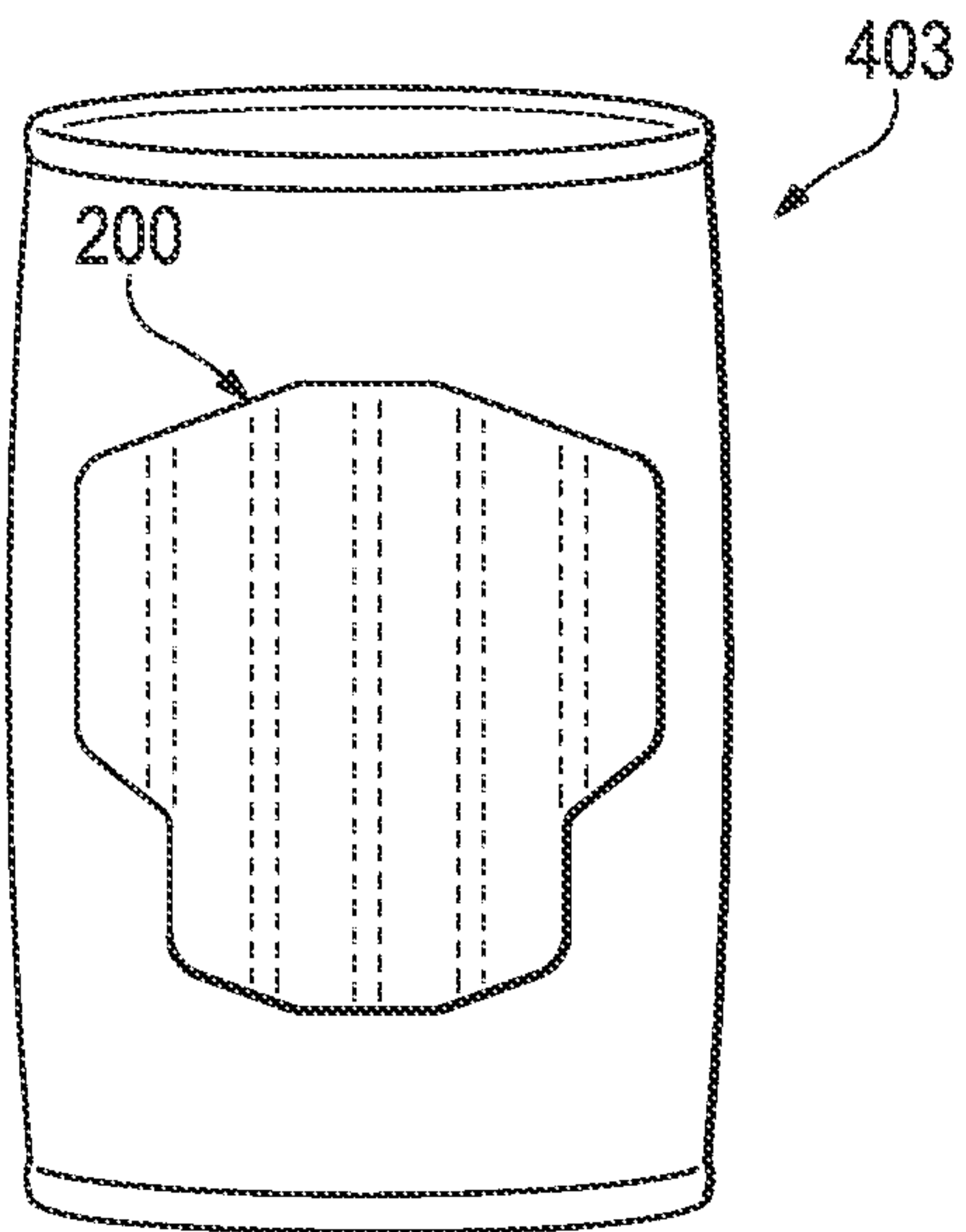
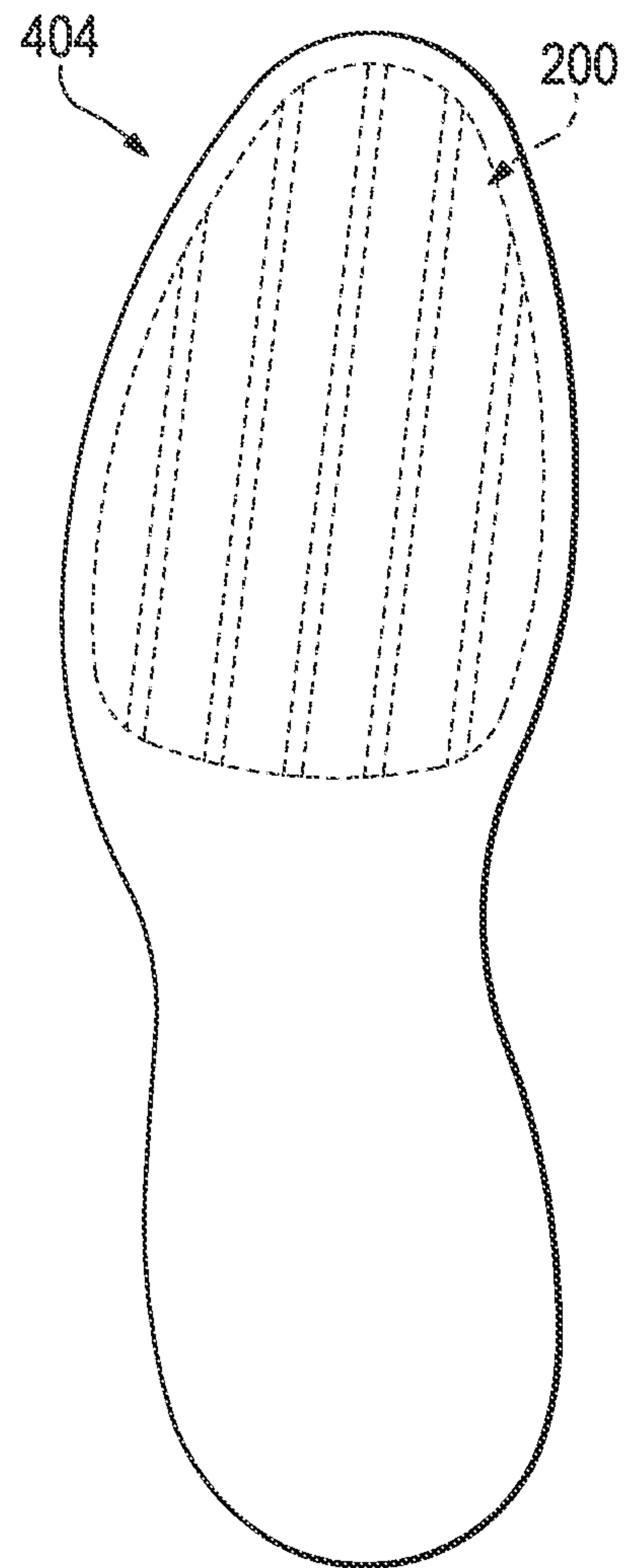
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**Figure 17B**

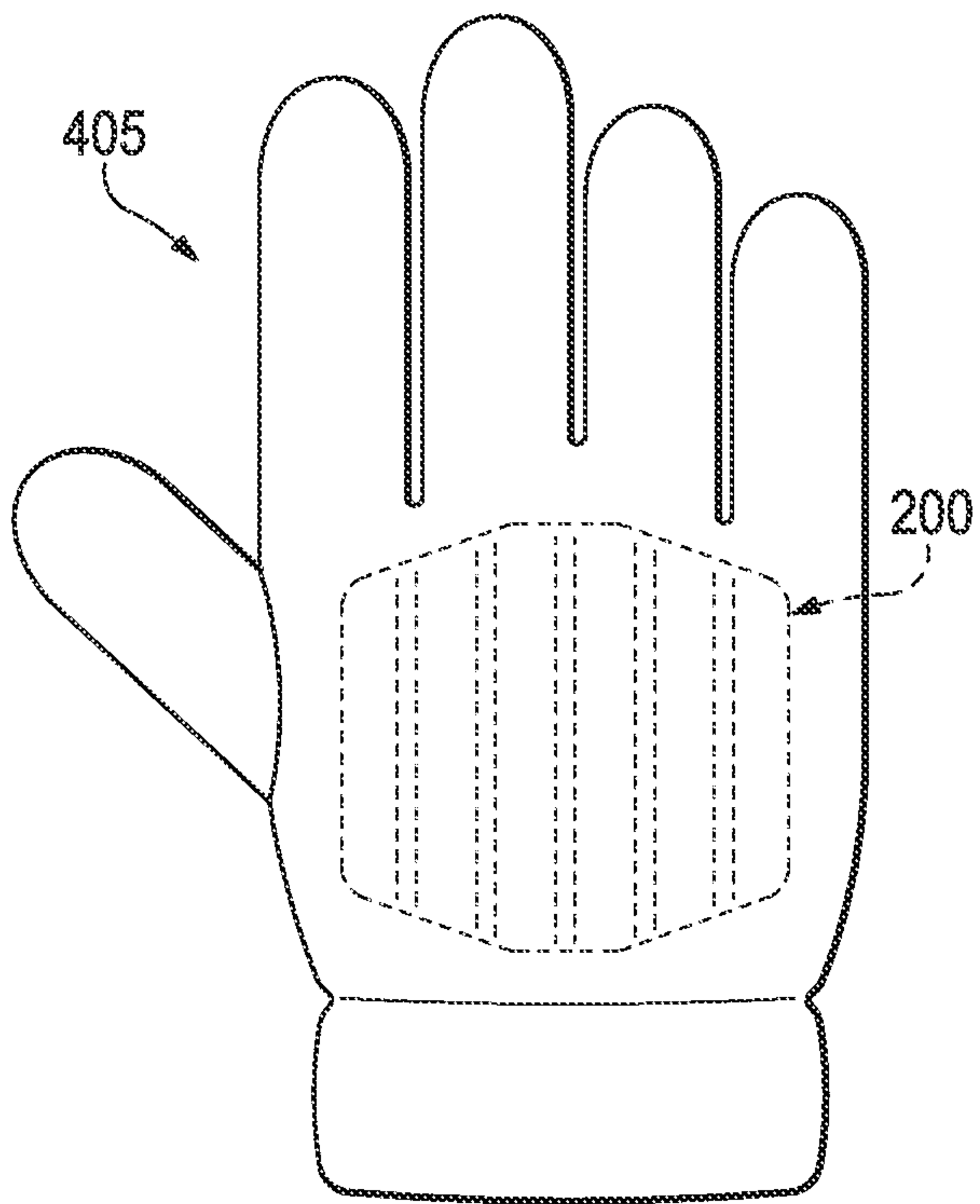
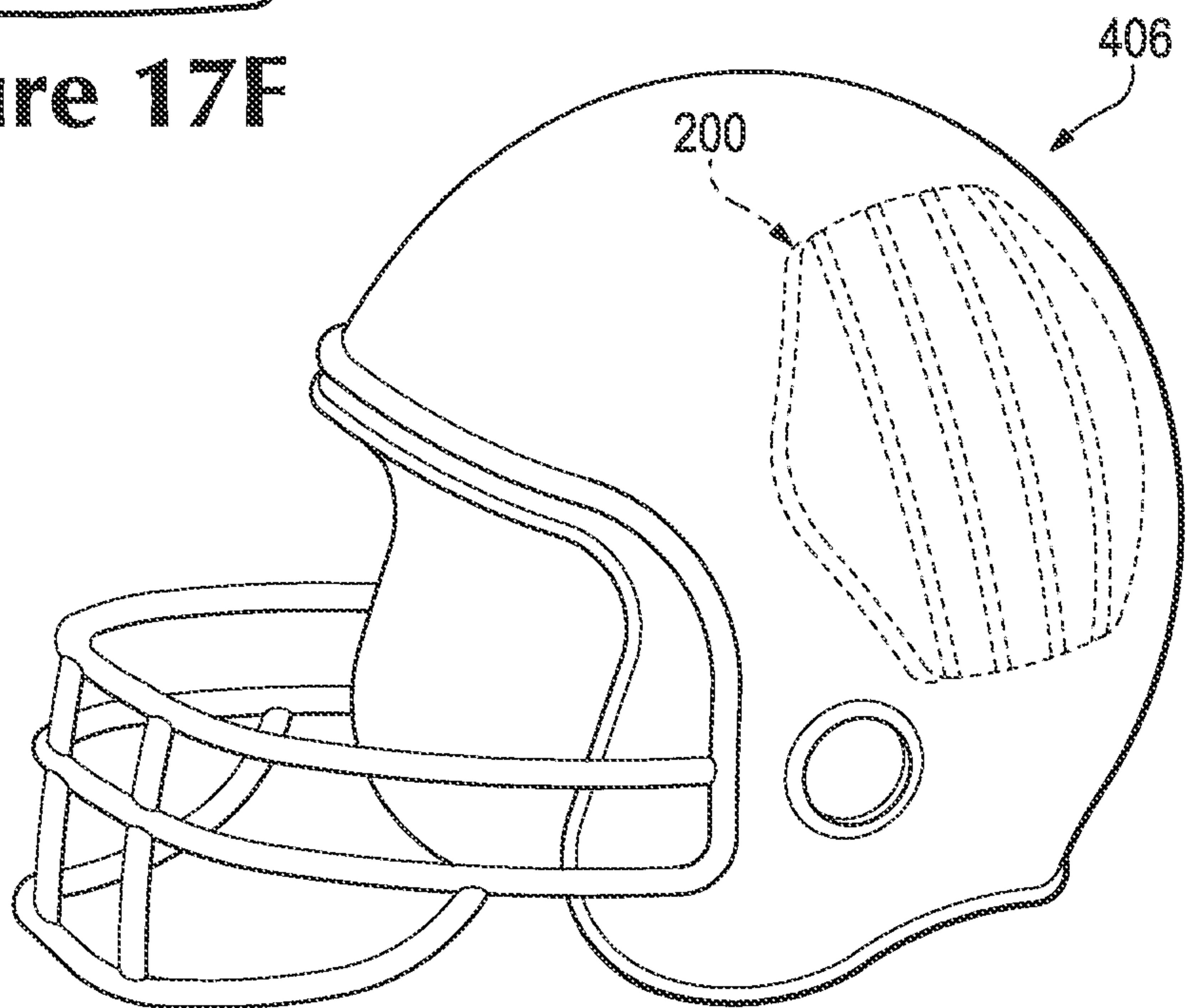
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**Figure 17C**

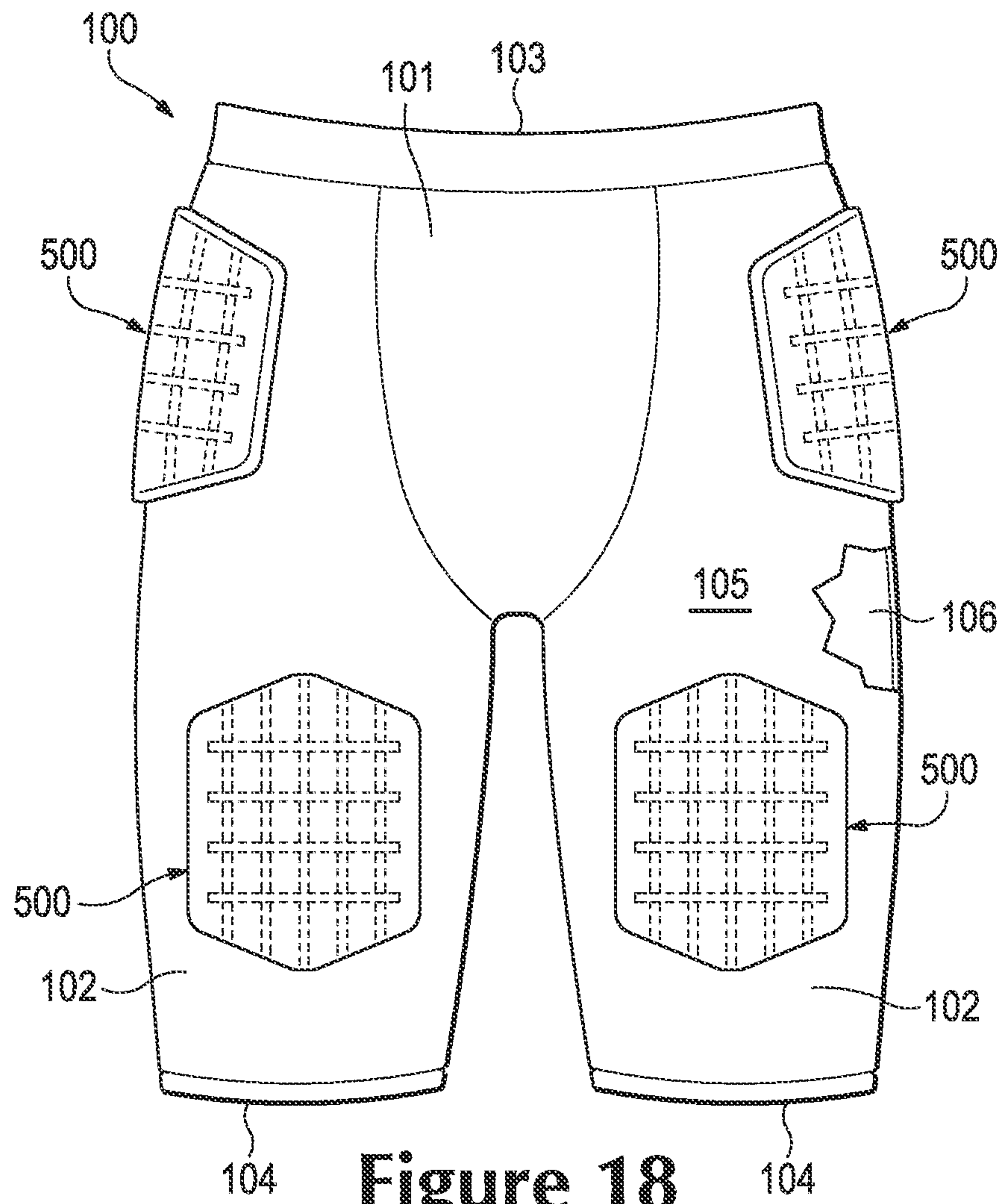
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**Figure 17D****Figure 17E**

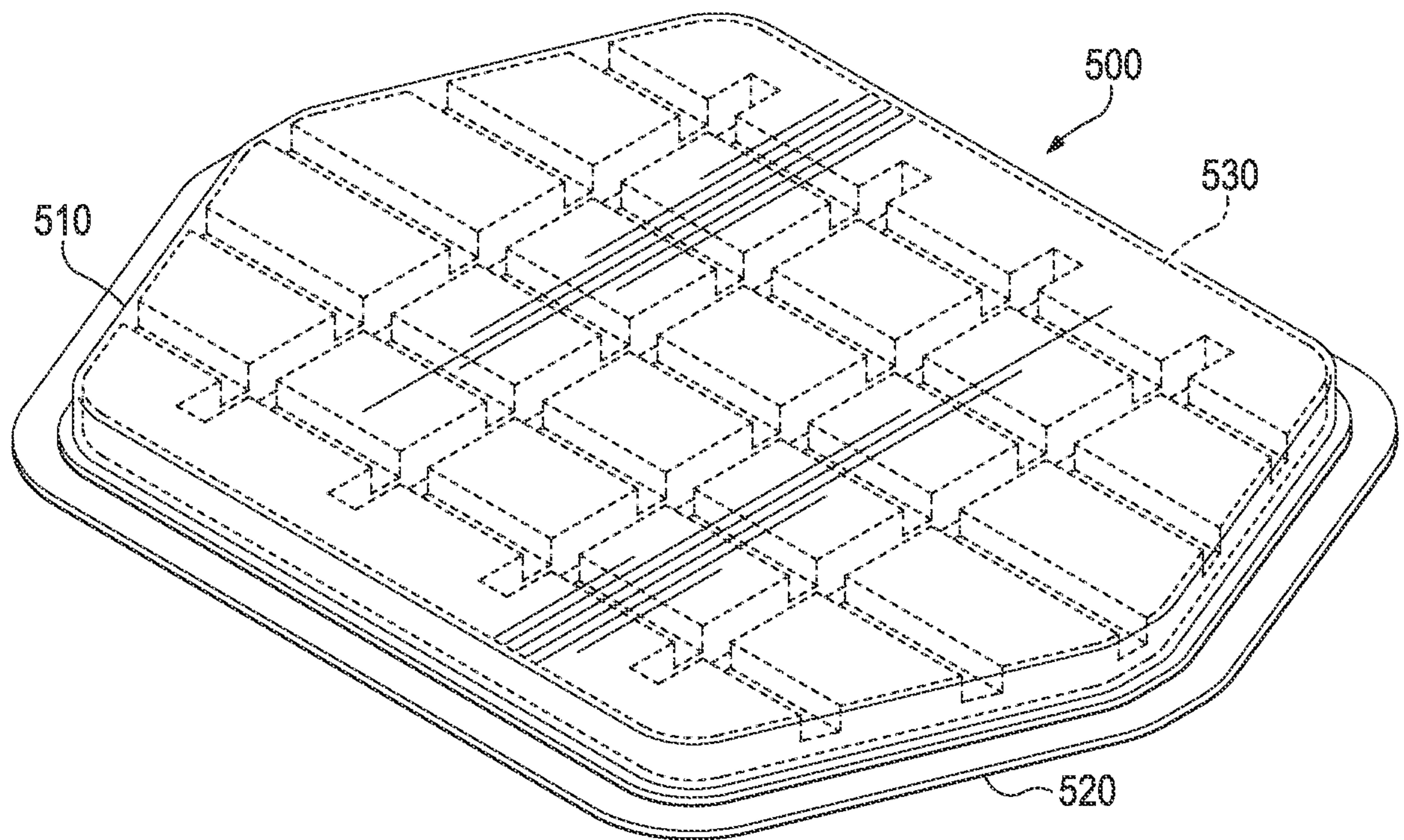
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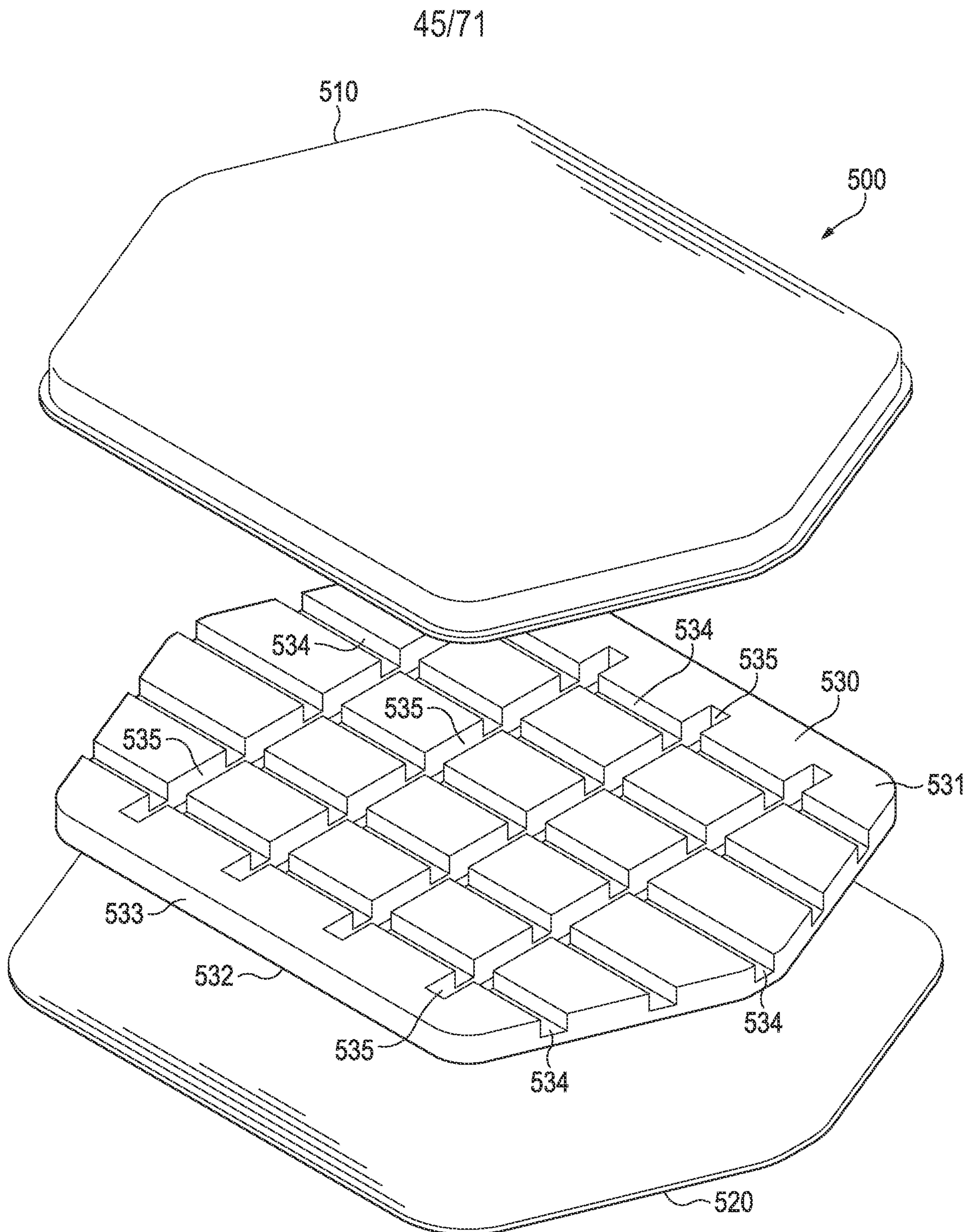
**Figure 17F****Figure 17G**

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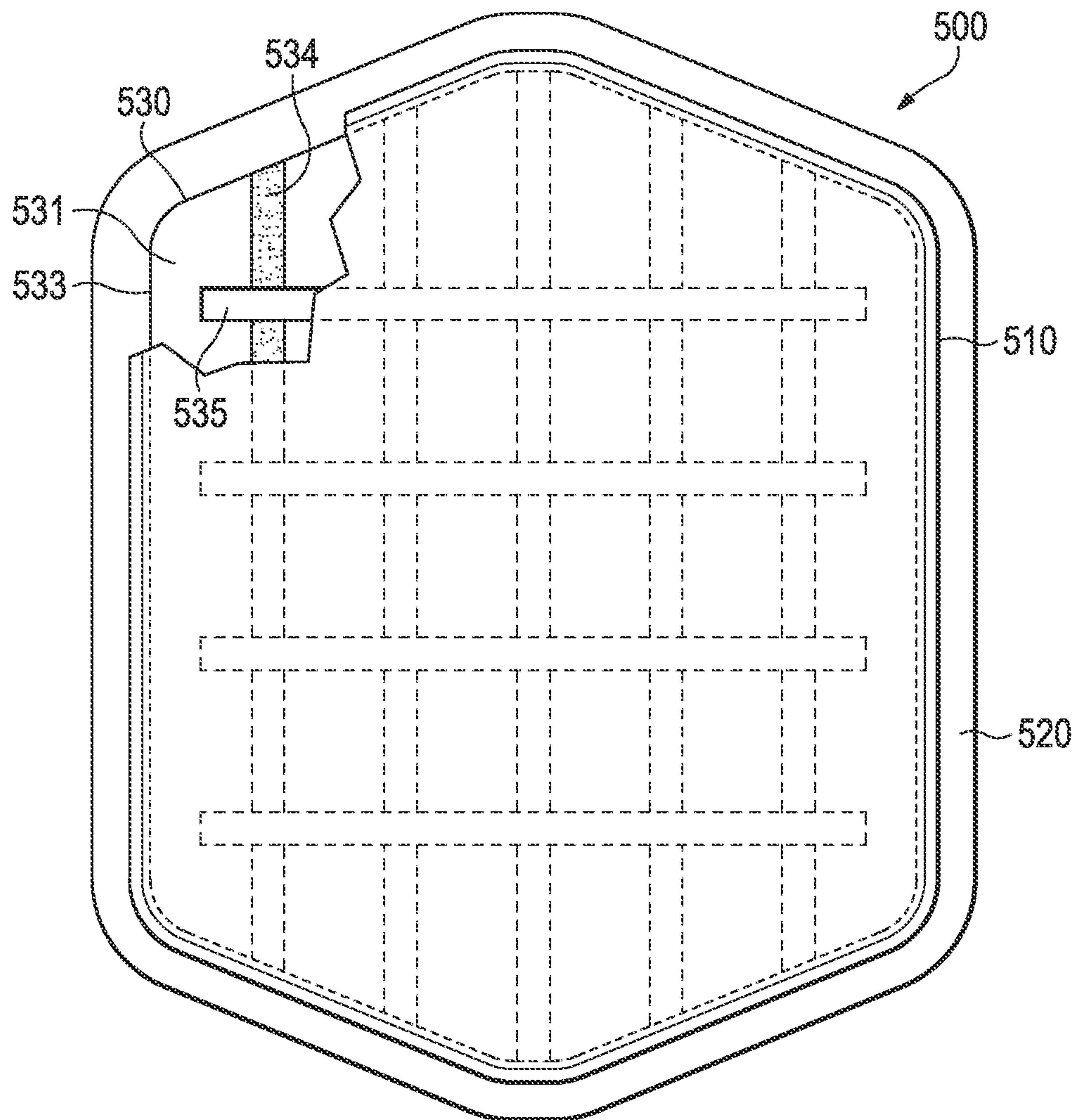
**Figure 18**

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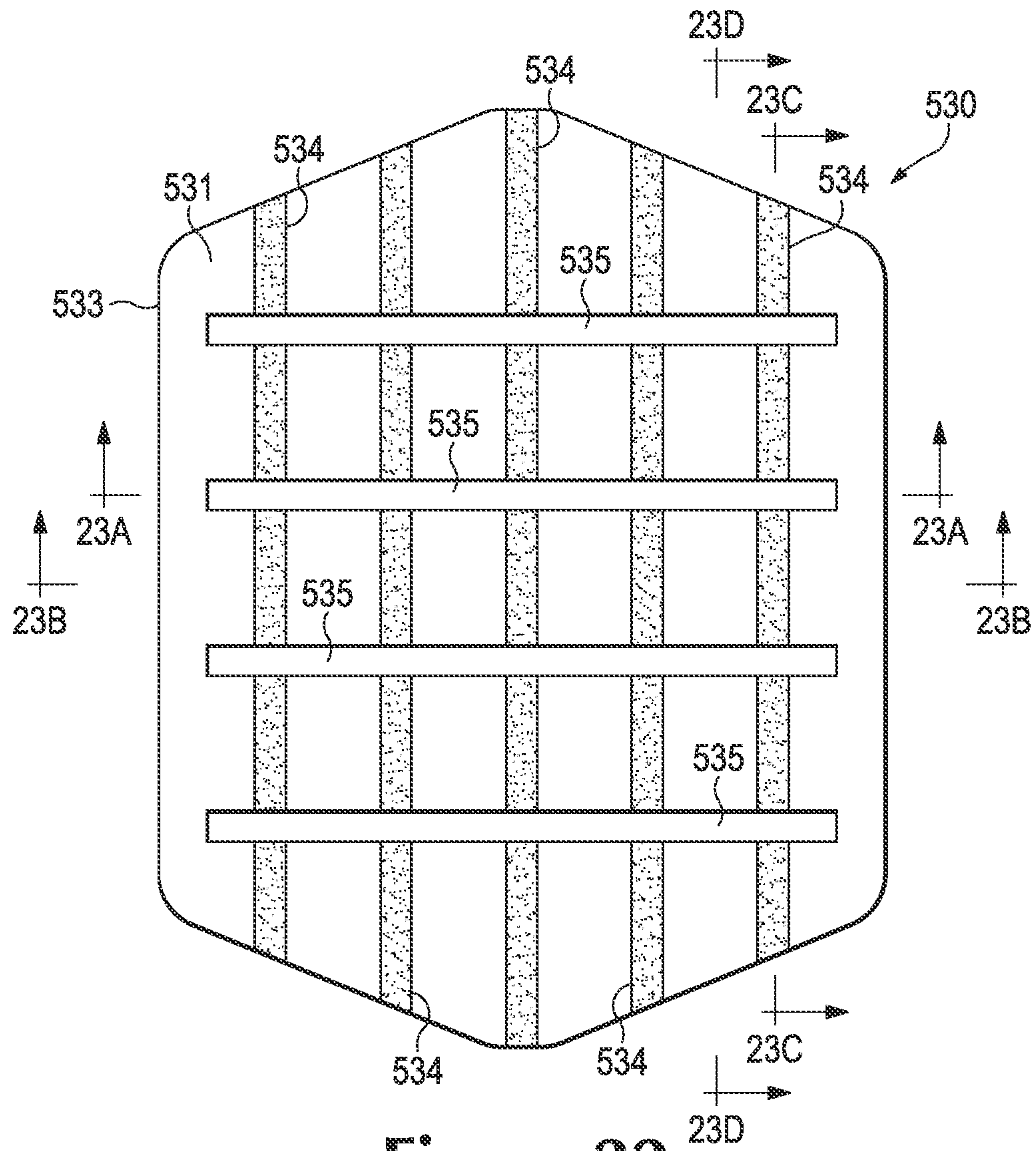
**Figure 19**

**Figure 20**

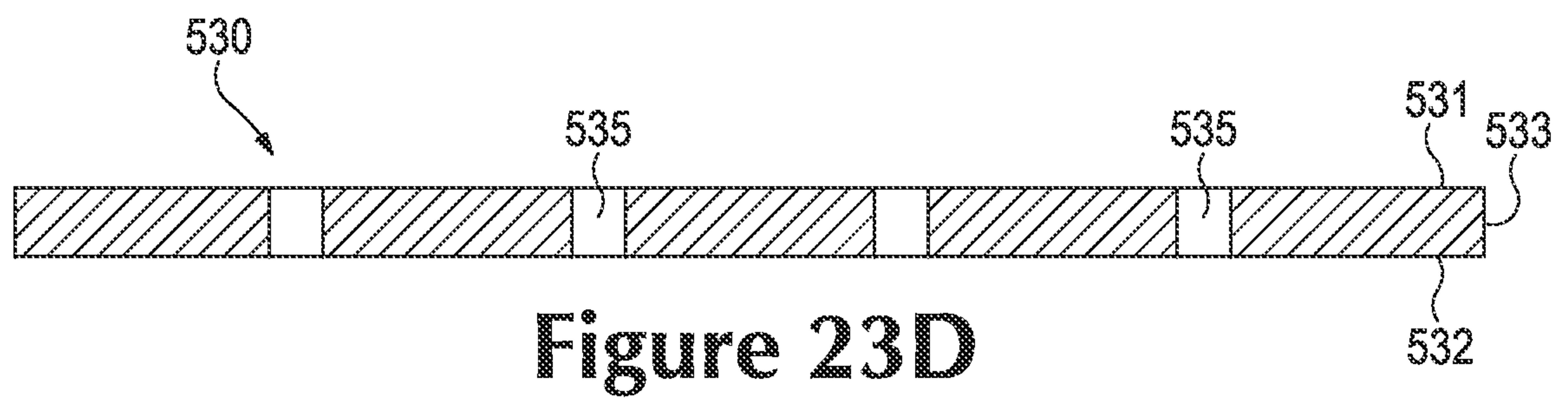
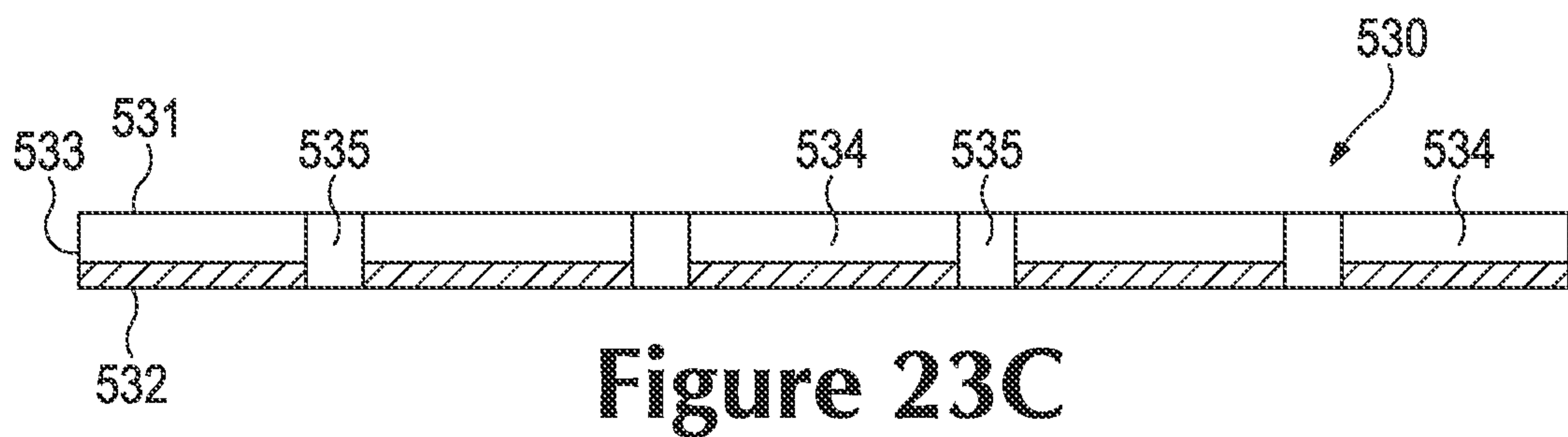
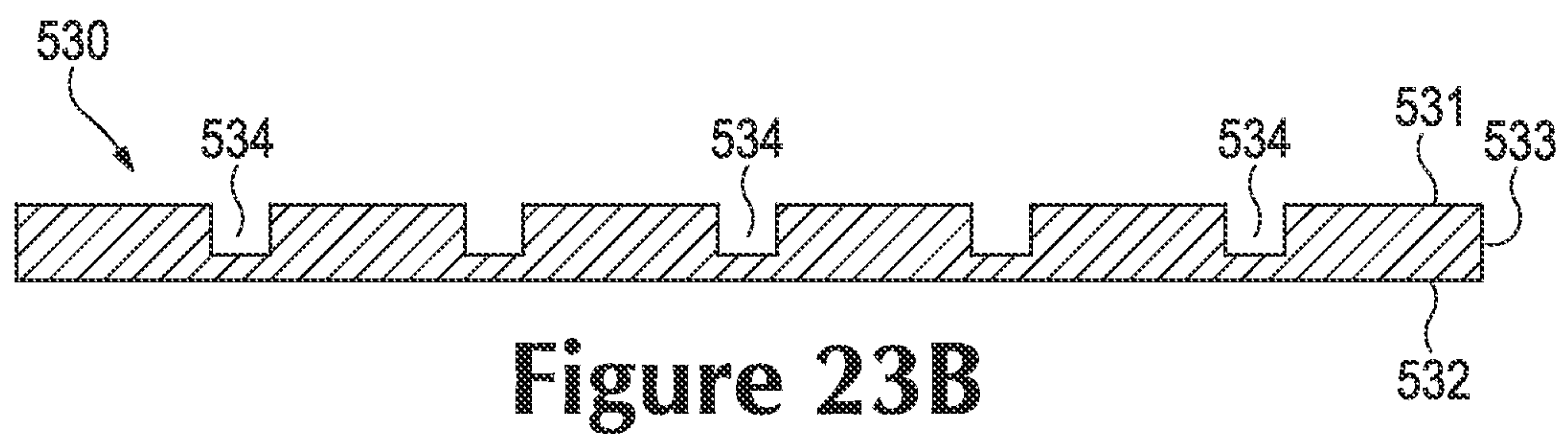
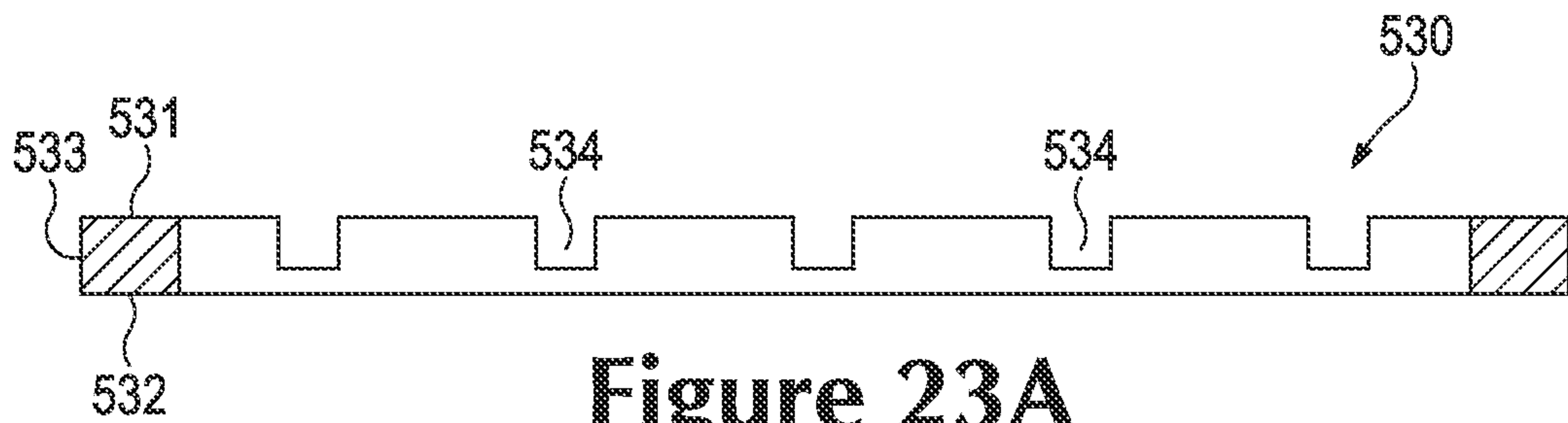
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**Figure 21**

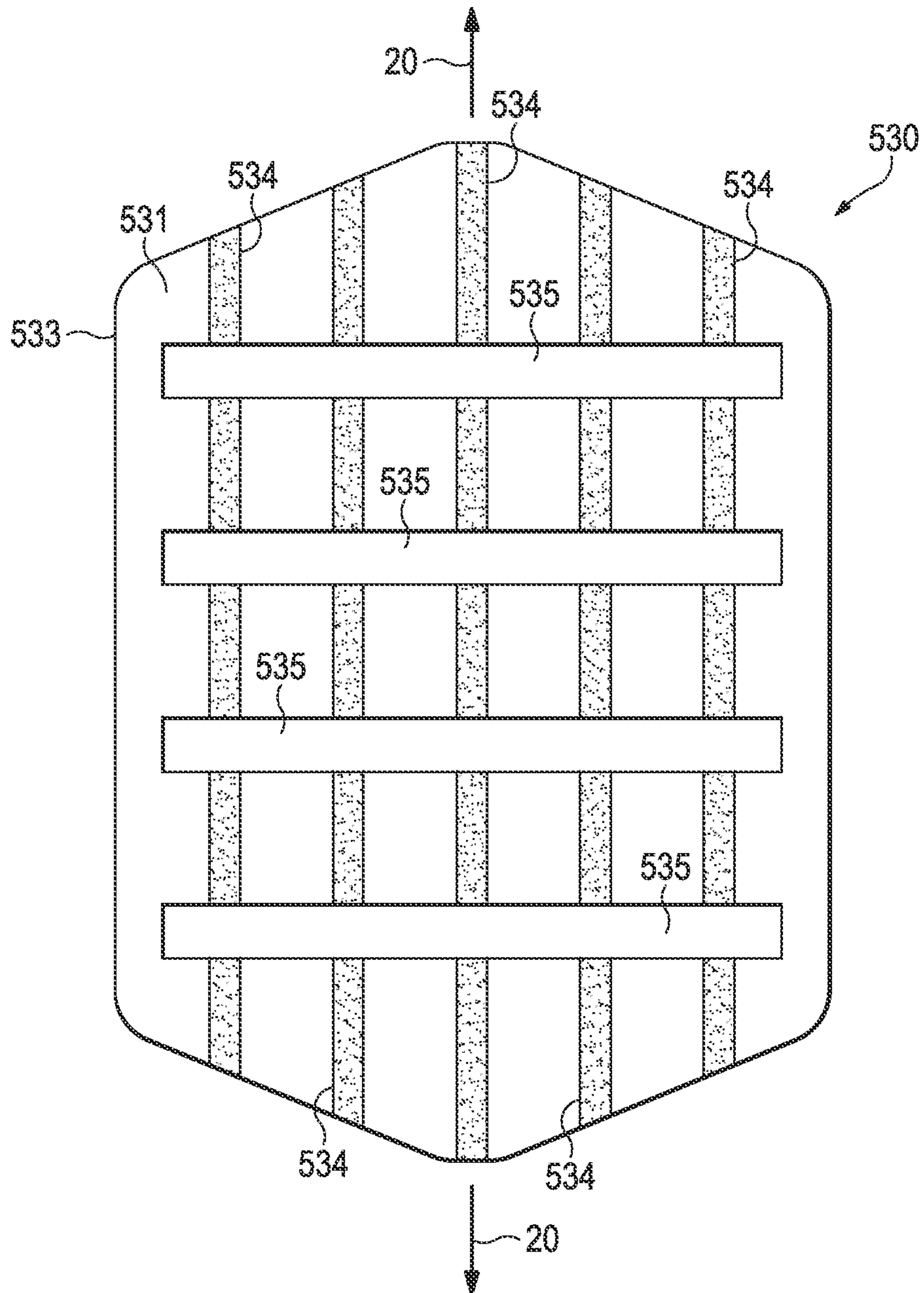
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**Figure 22**

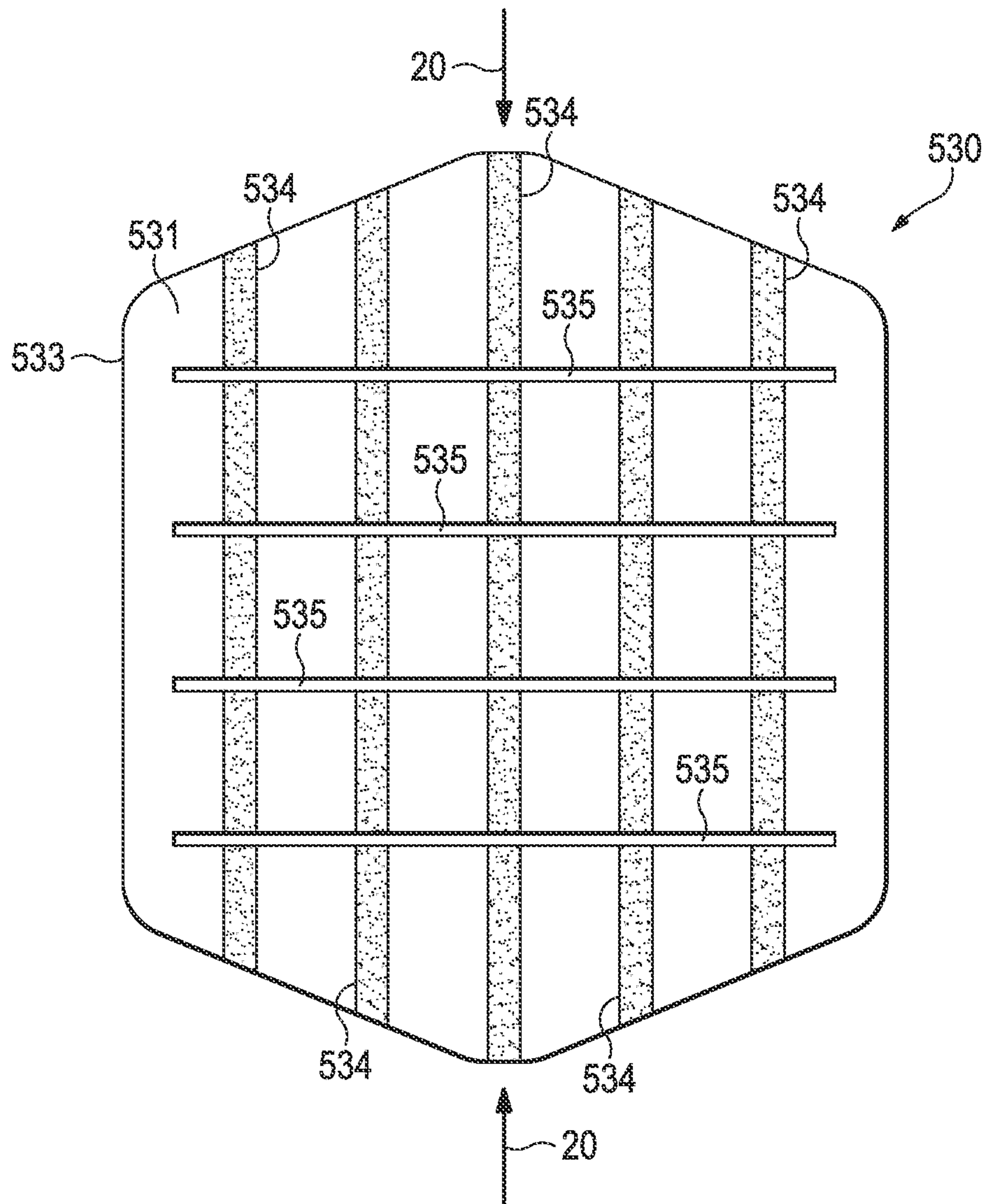
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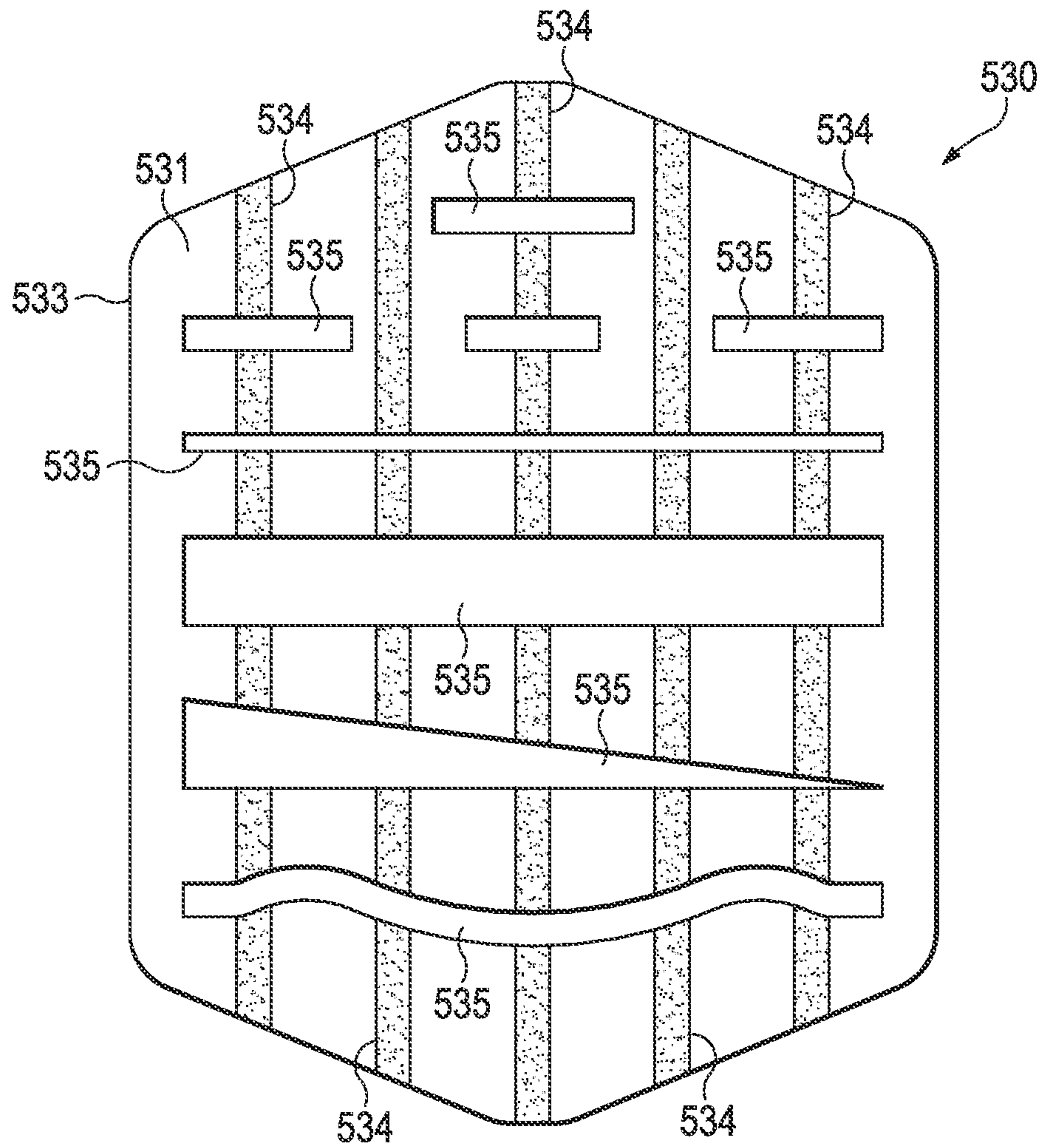
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**Figure 24A**

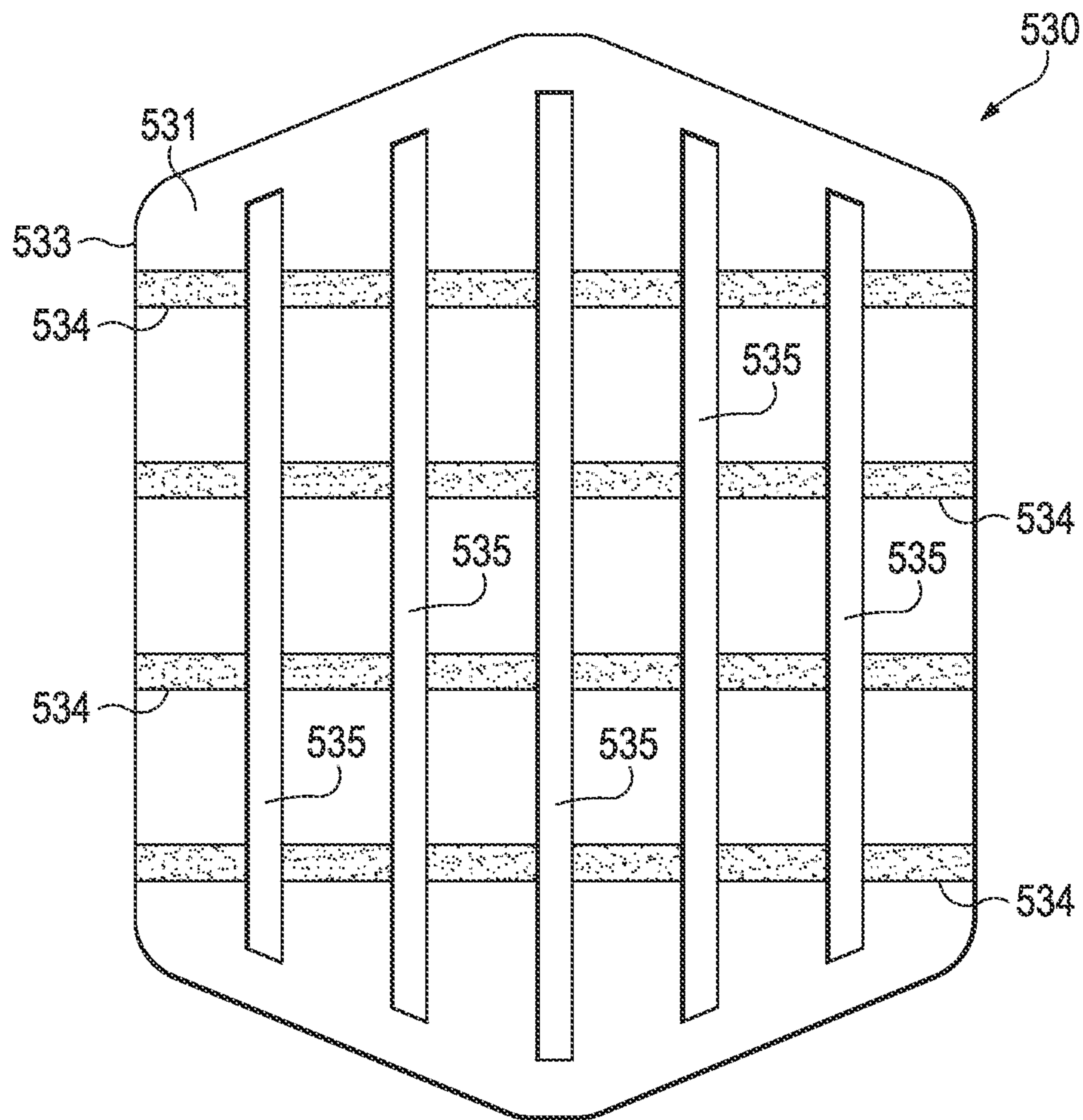
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**Figure 24B**

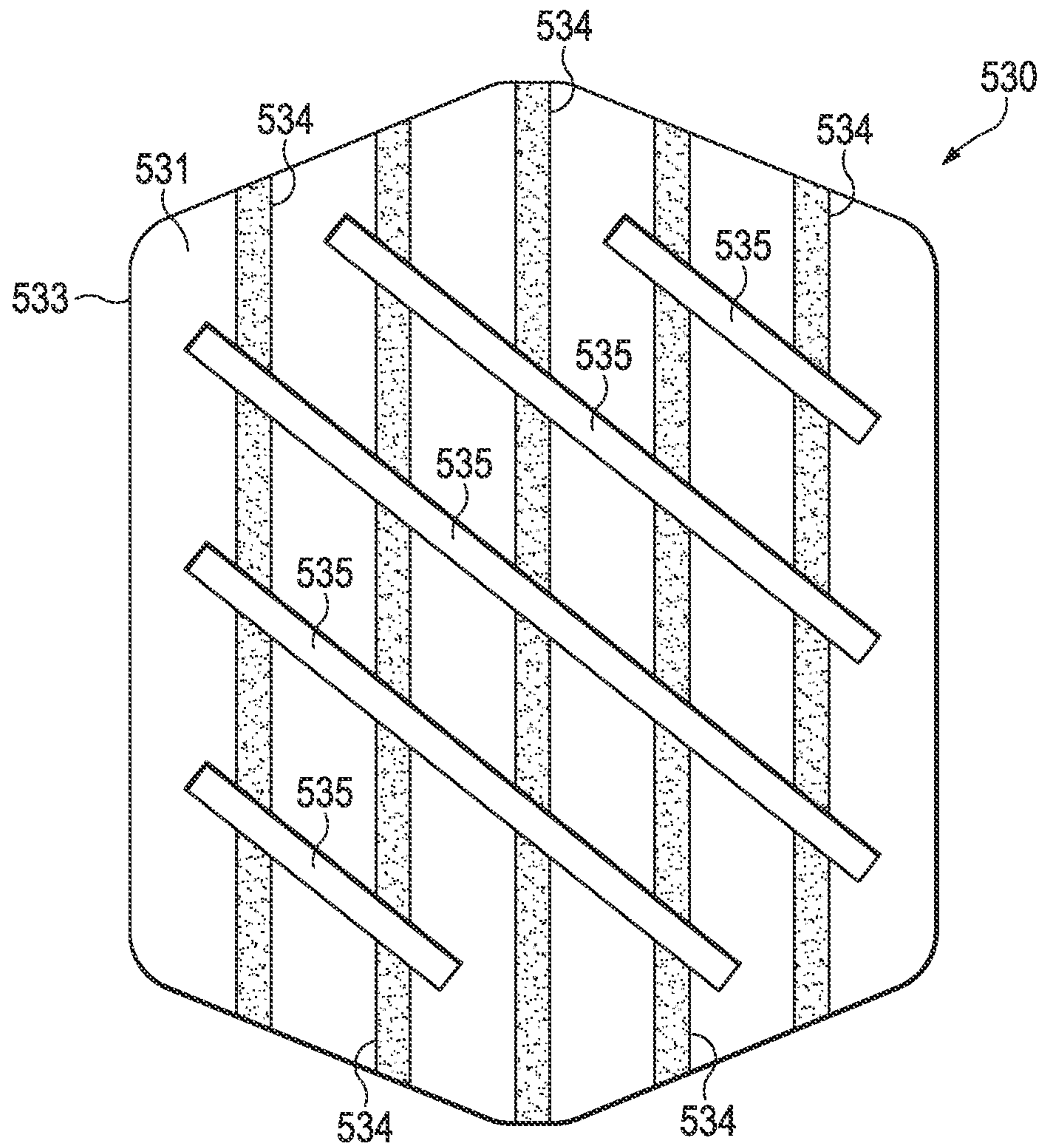
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**Figure 25A**

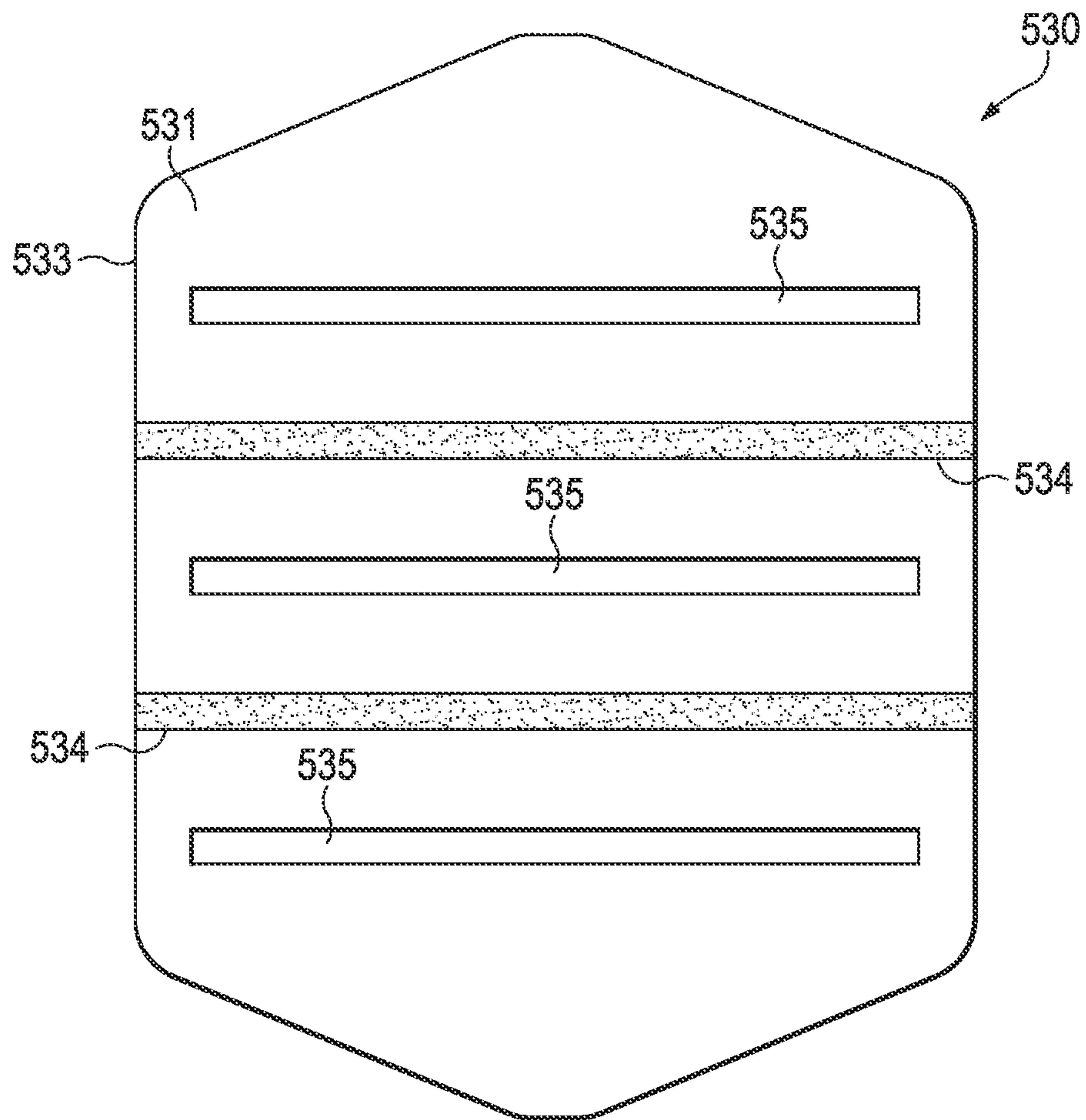
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**Figure 25B**

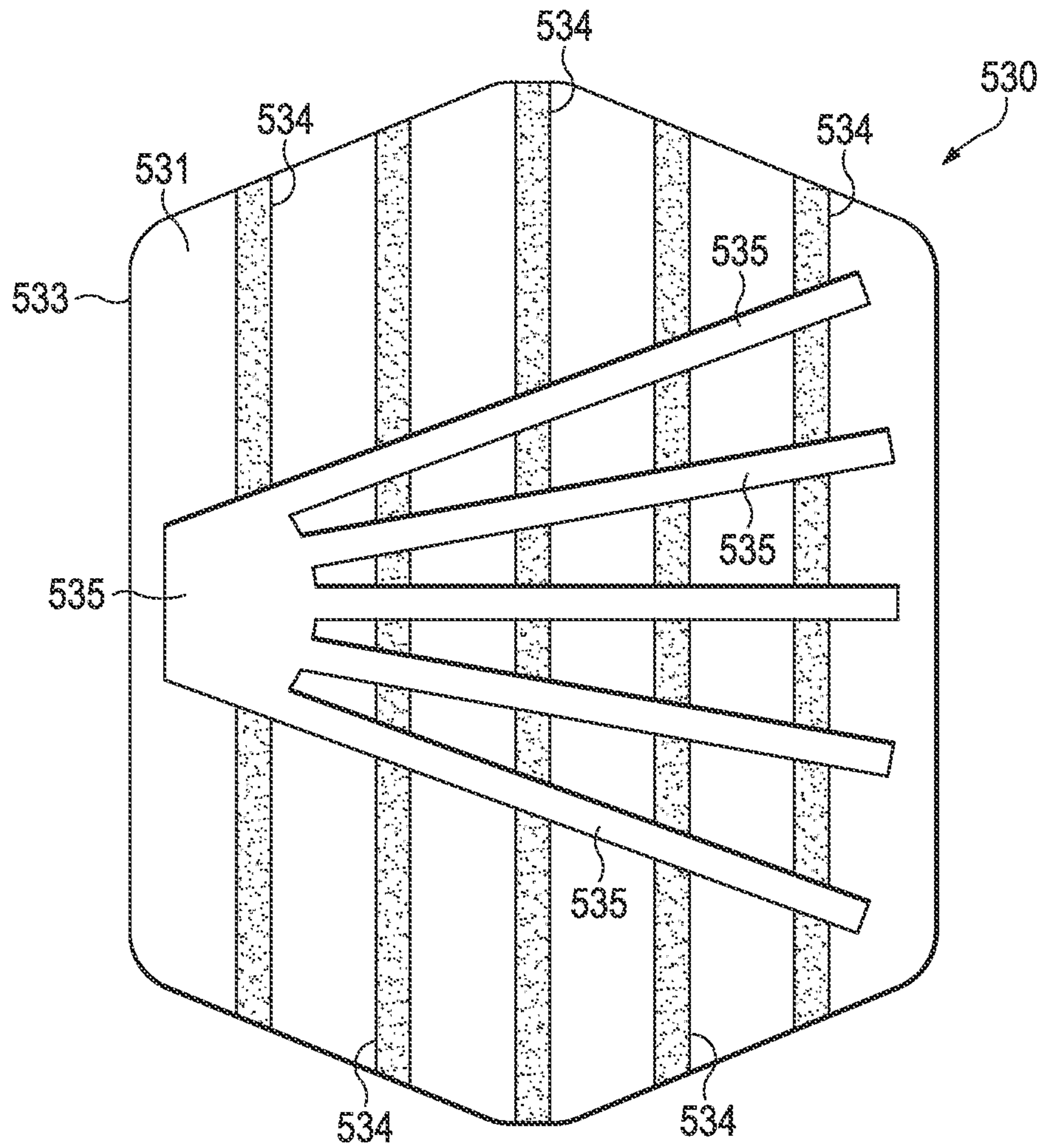
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**Figure 25C**

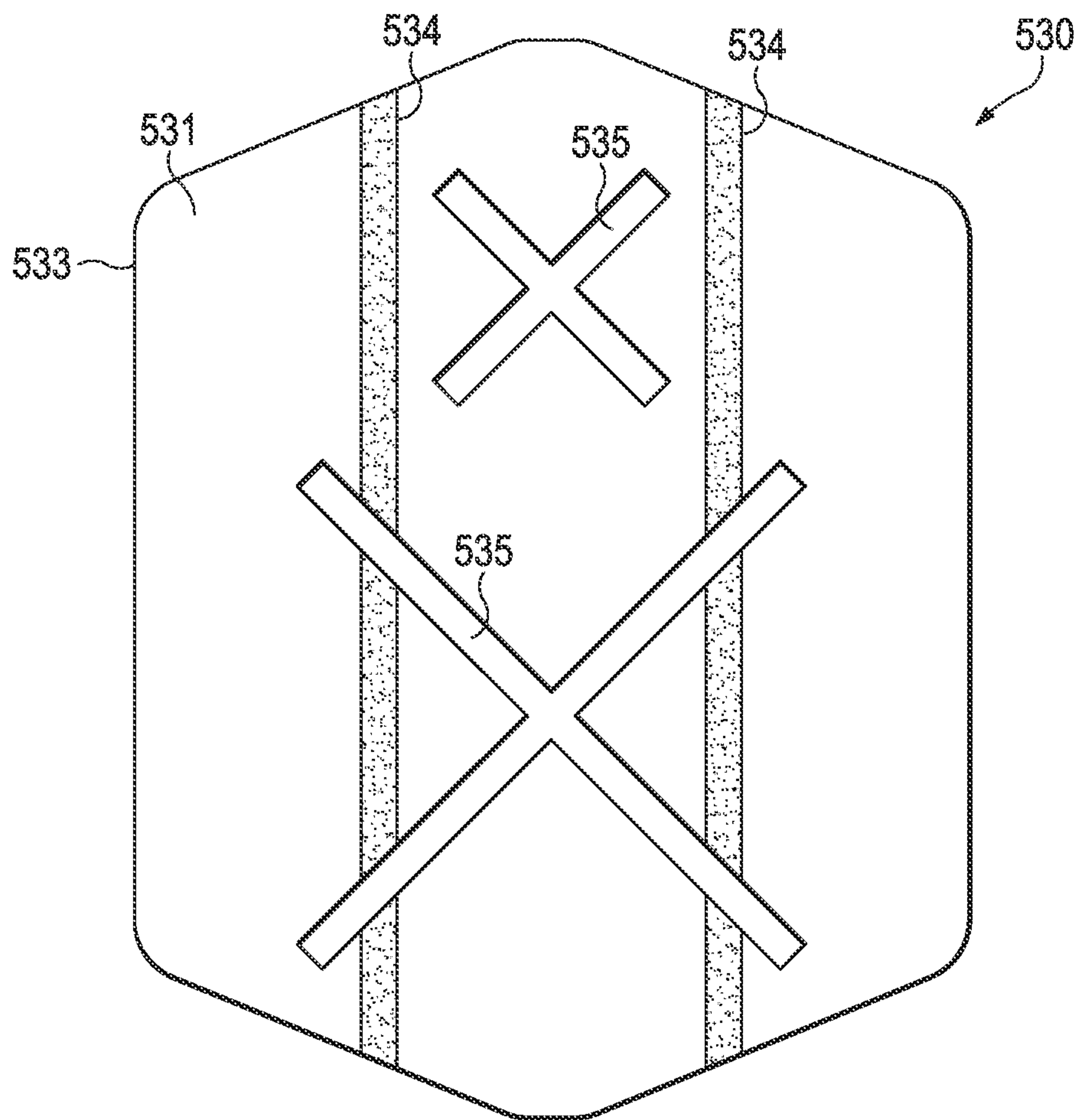
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**Figure 25D**

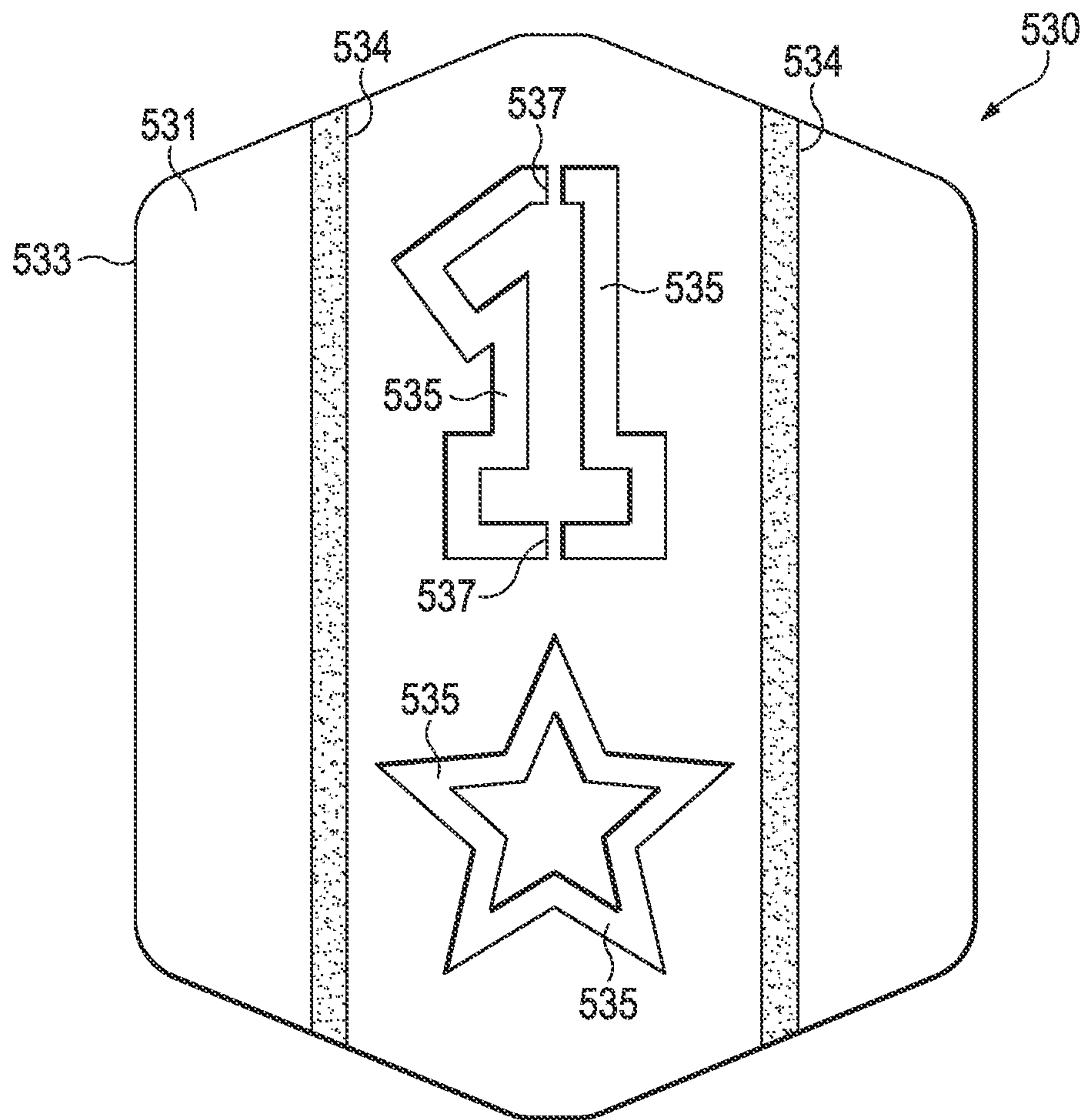
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**Figure 25E**

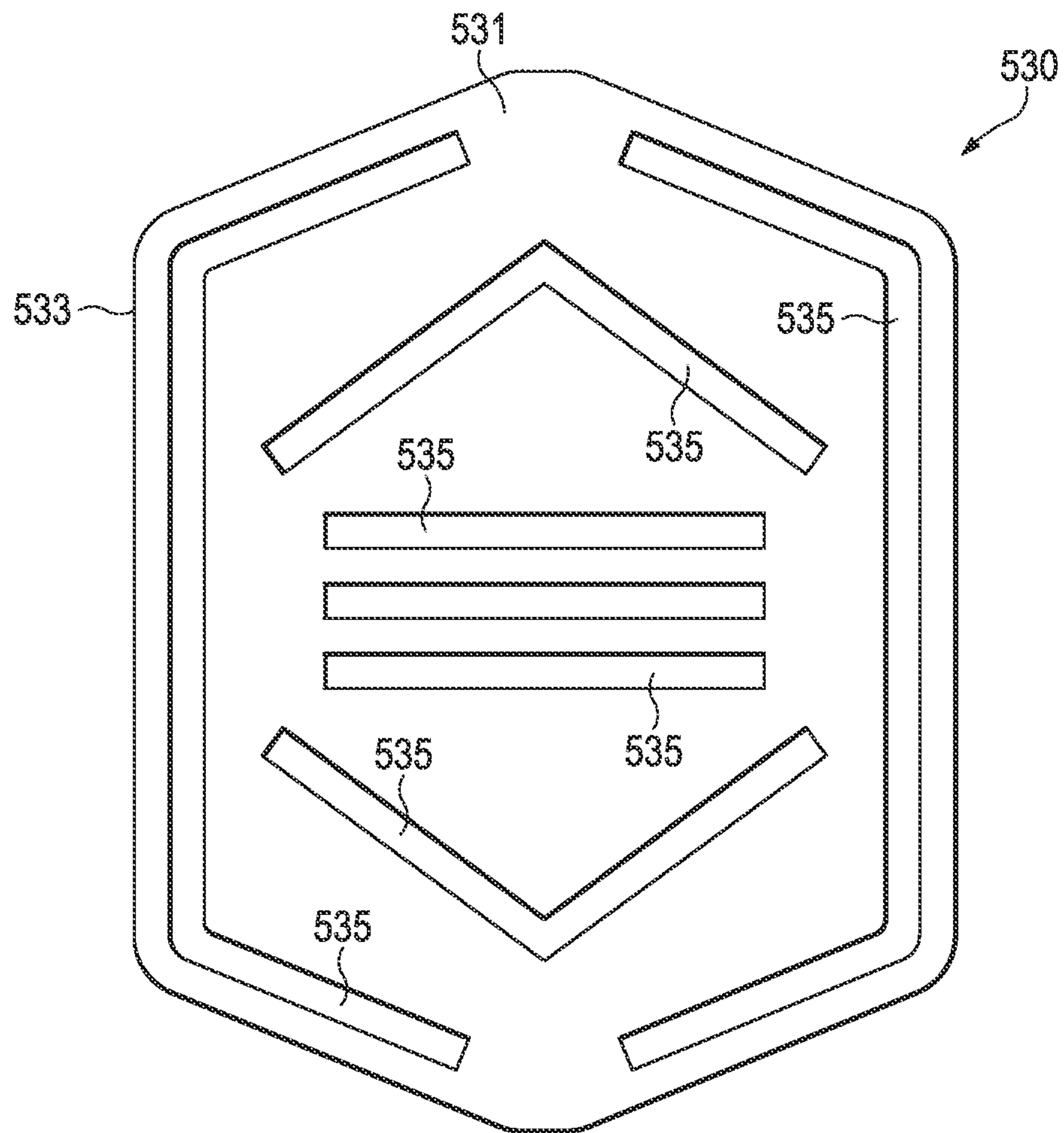
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**Figure 25F**

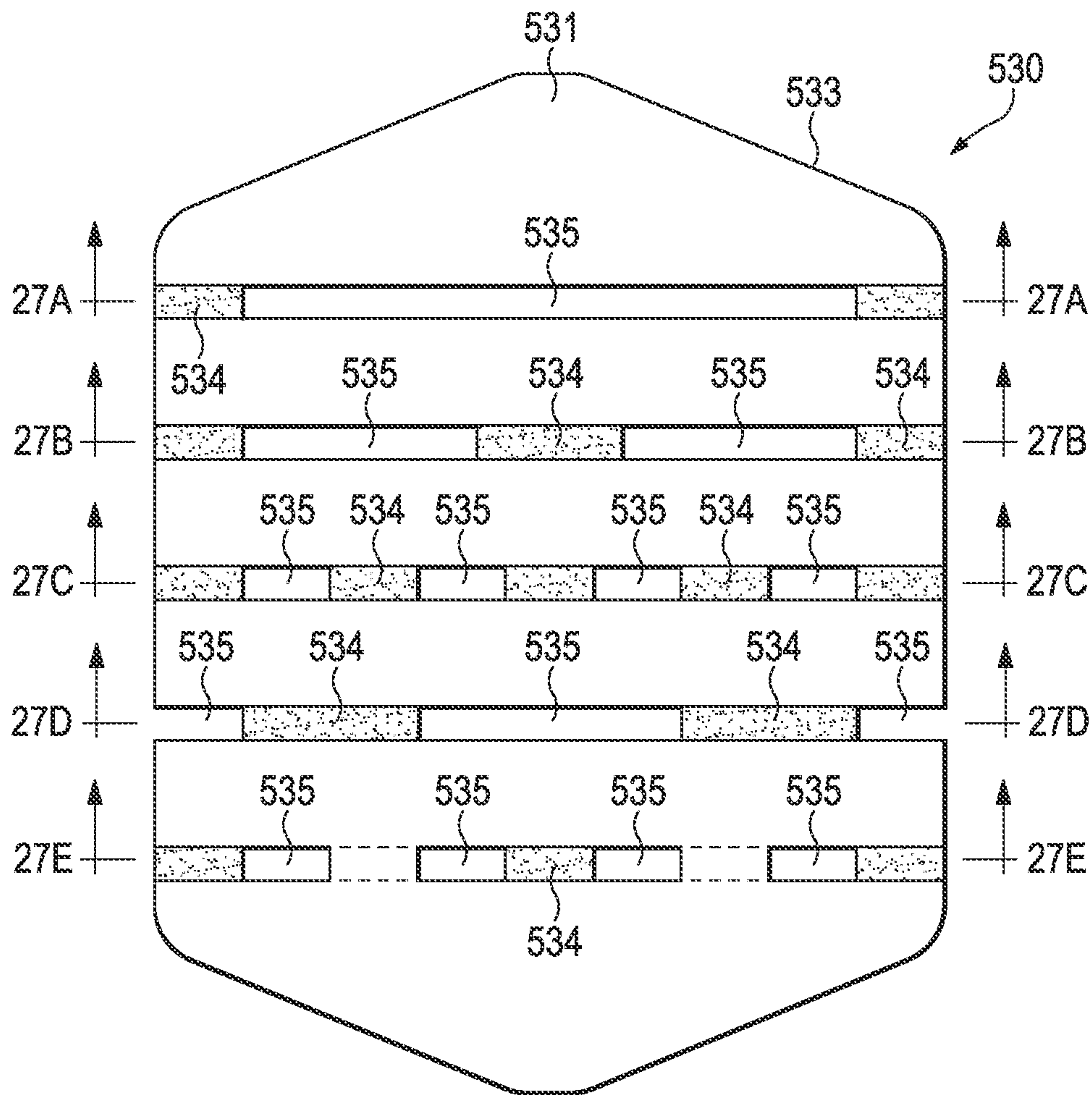
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**Figure 25G**

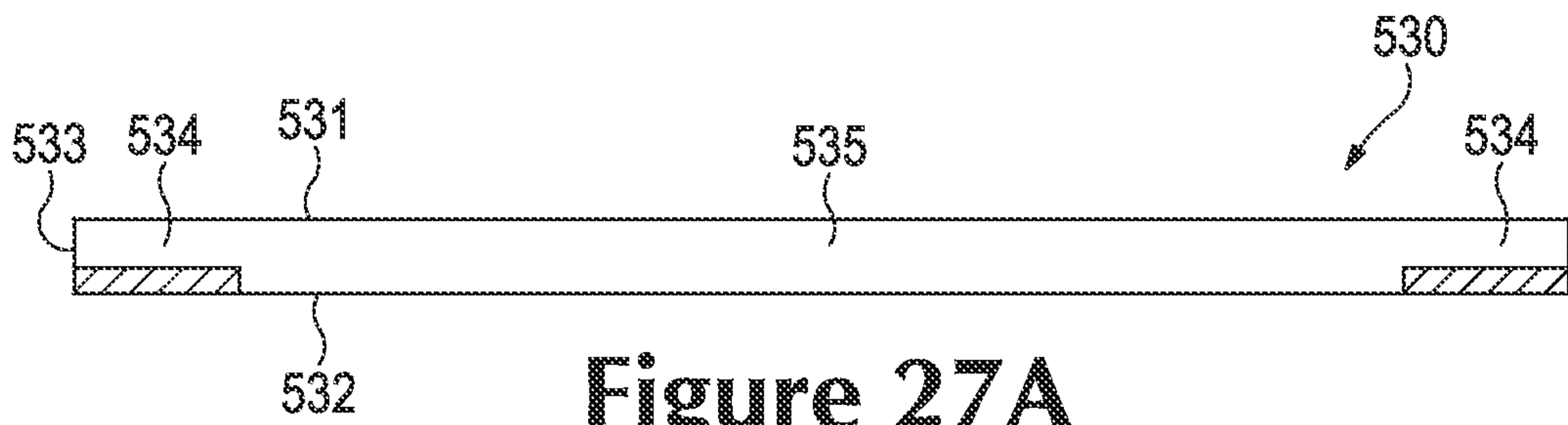
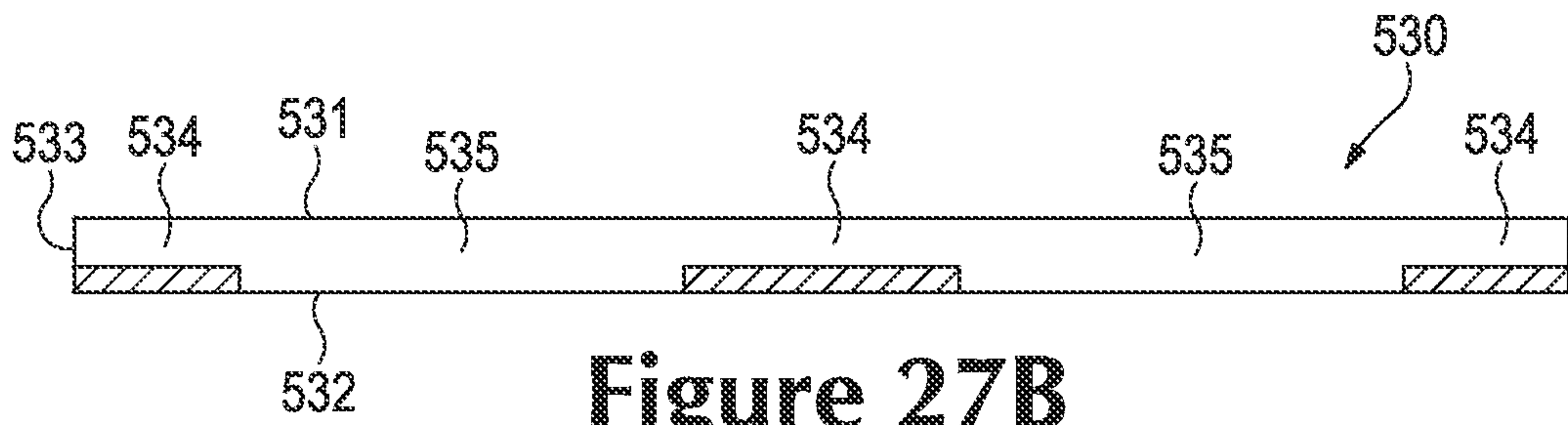
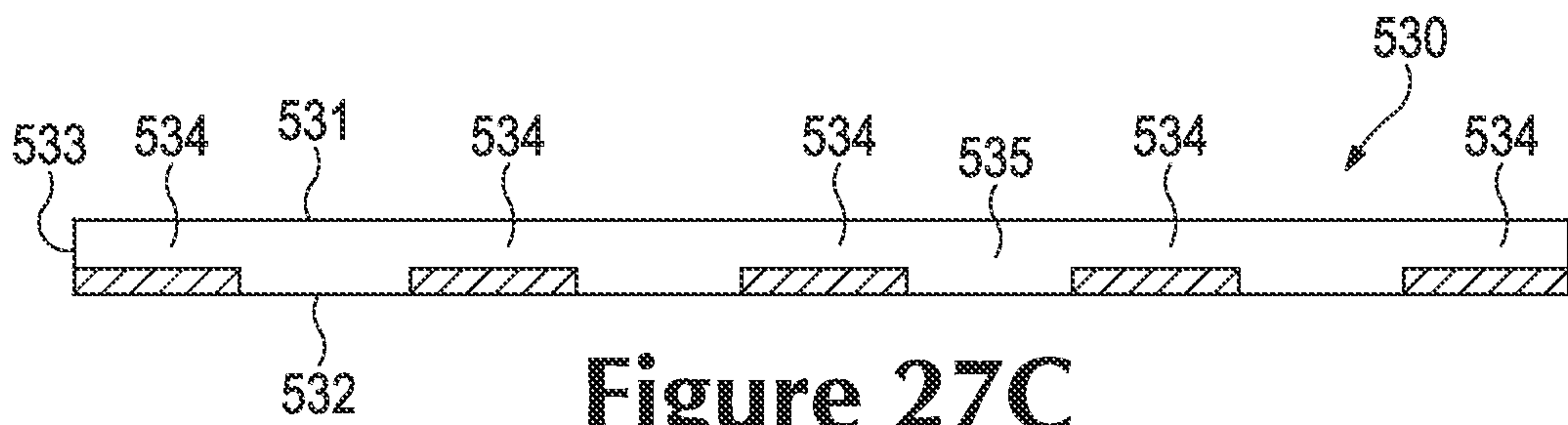
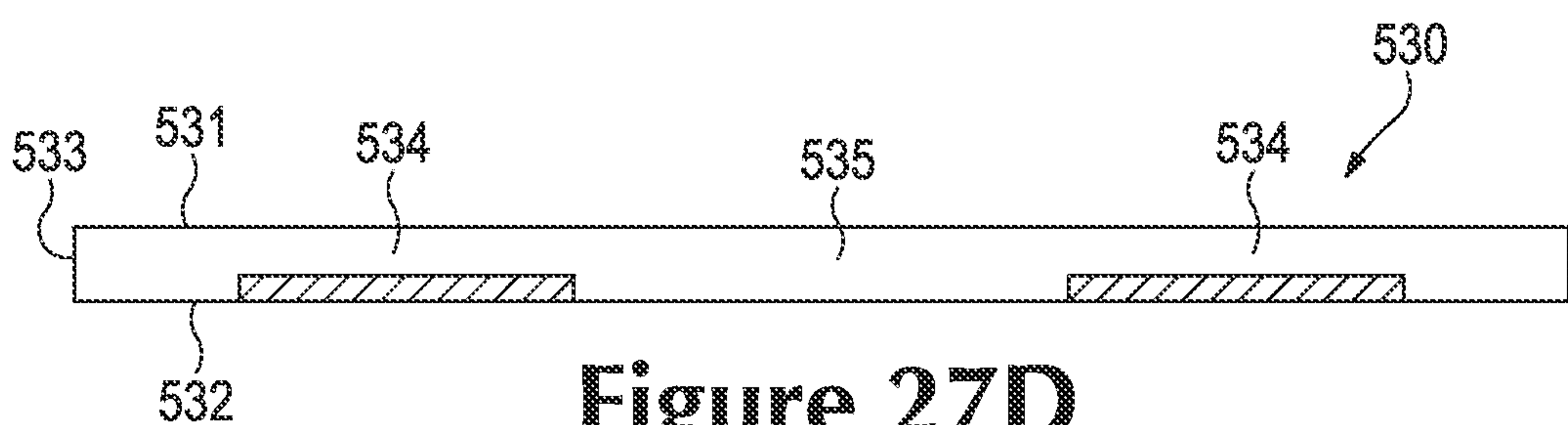
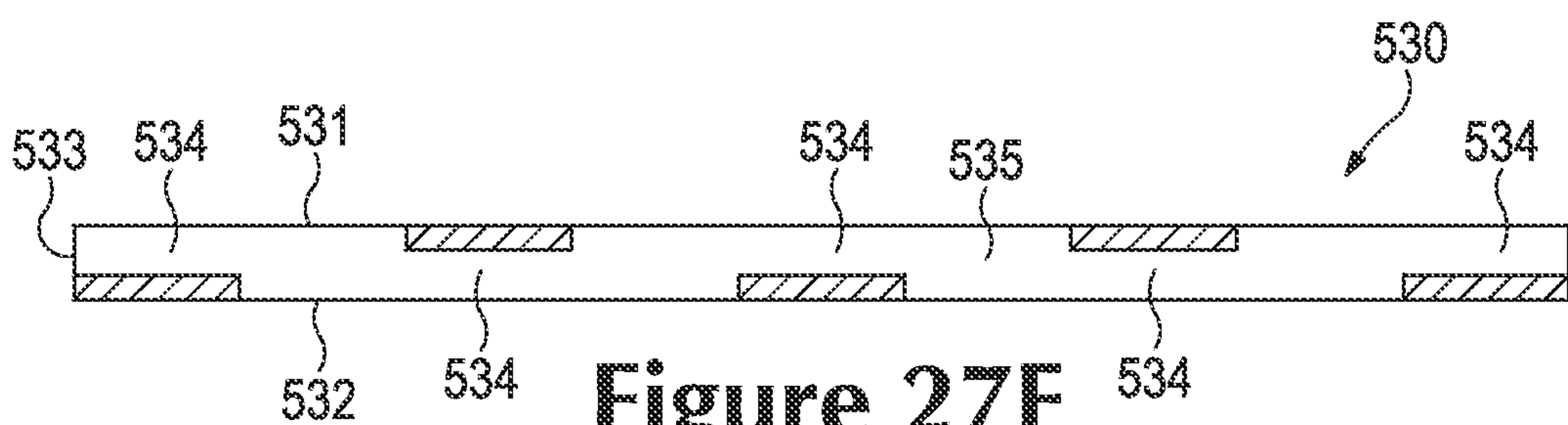
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**Figure 25H**

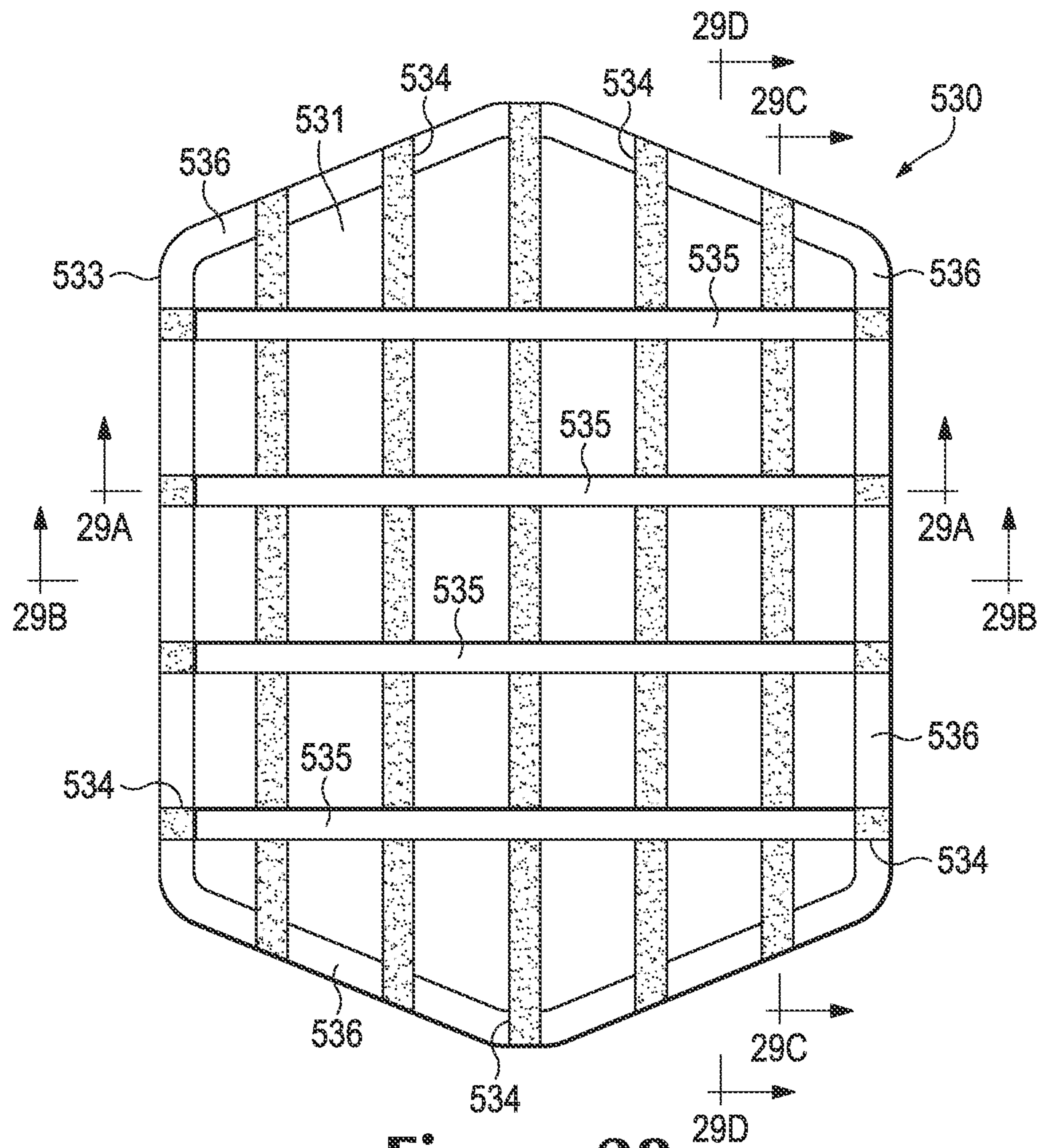
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**Figure 26**

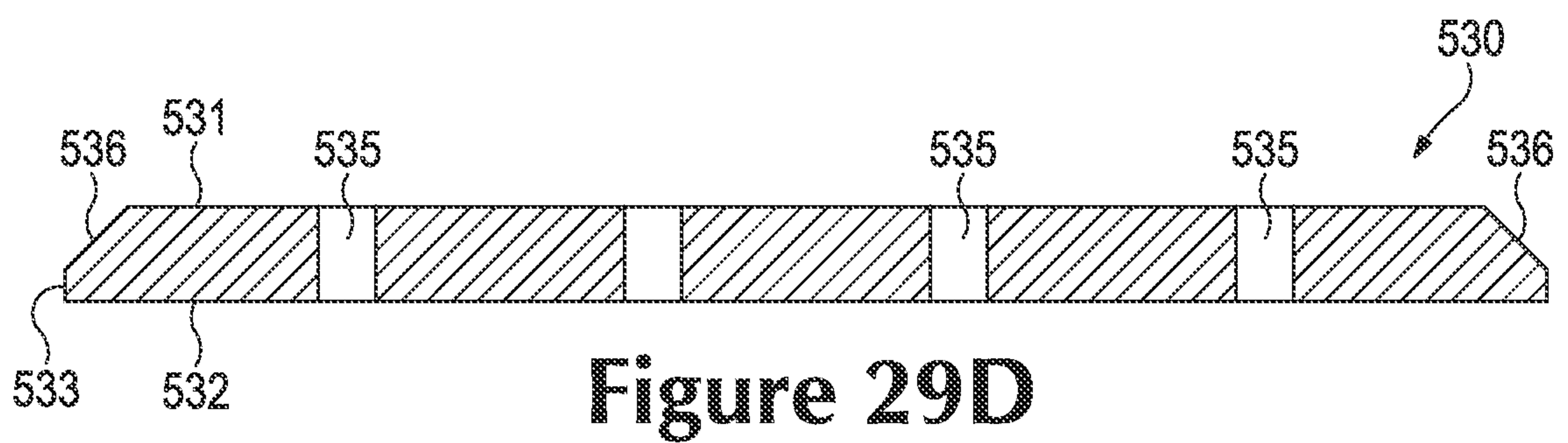
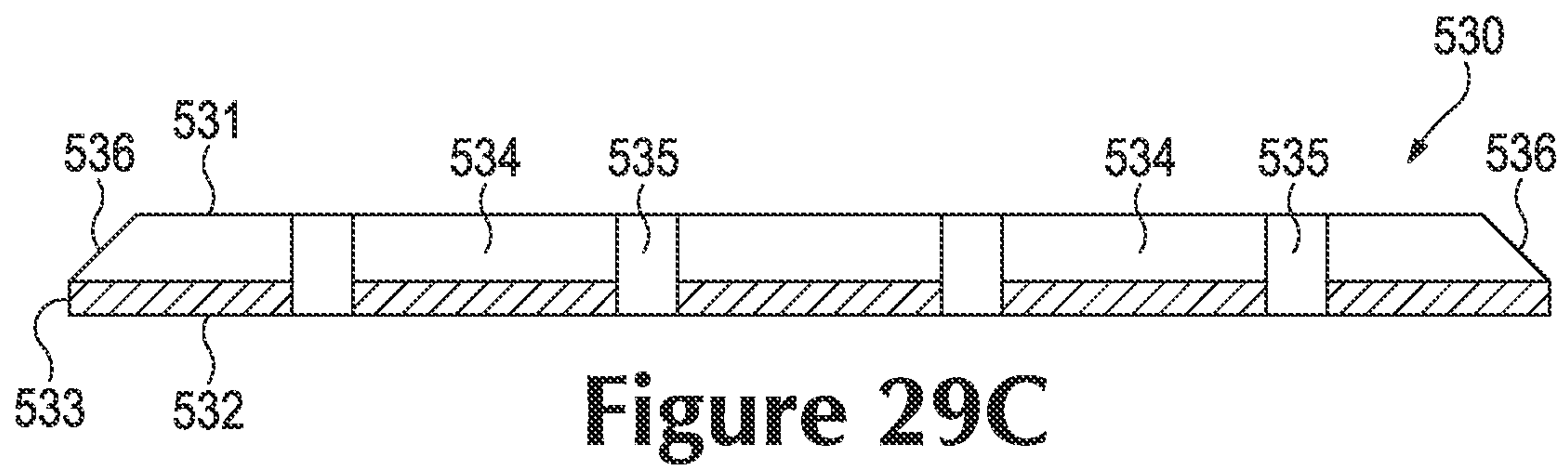
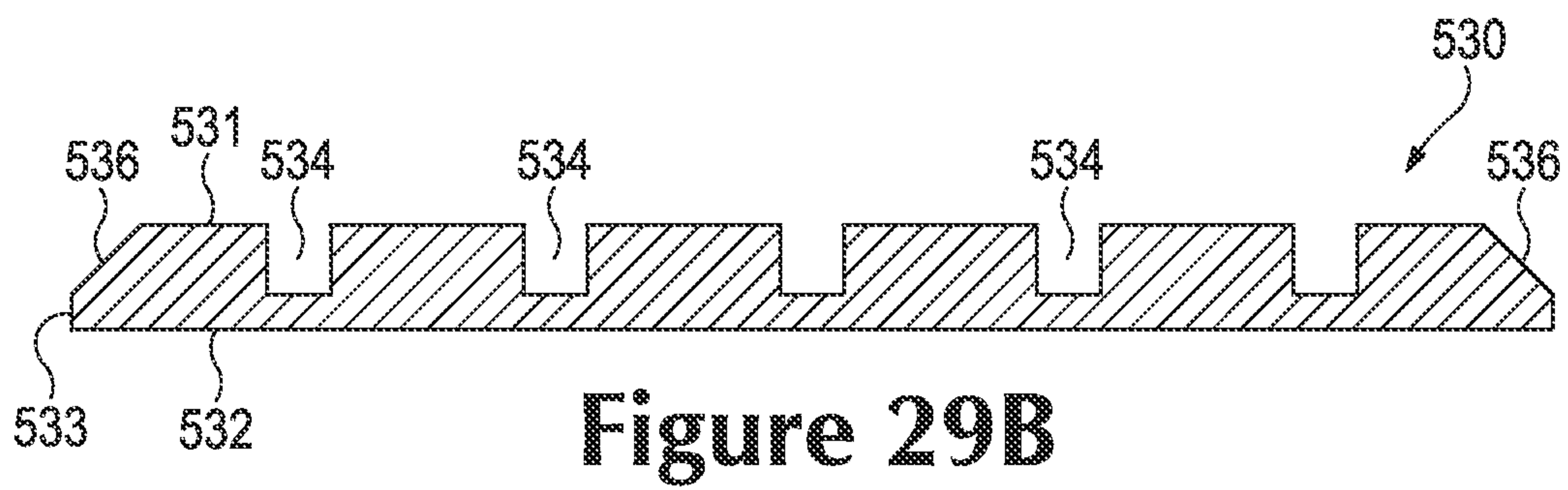
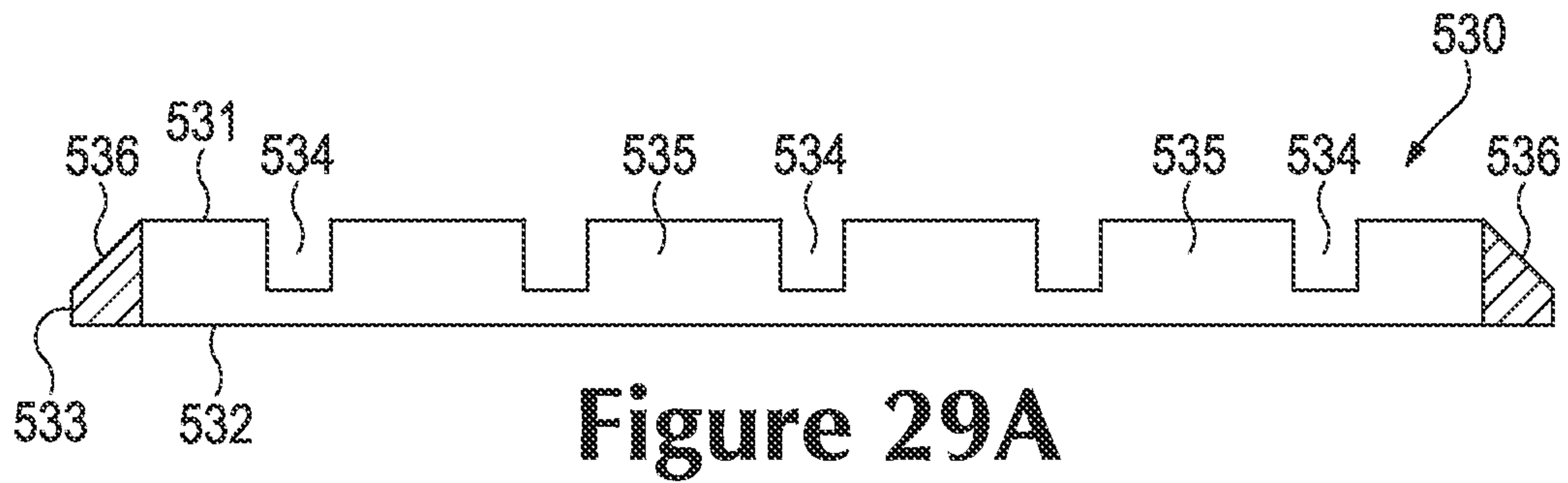
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**Figure 27A****Figure 27B****Figure 27C****Figure 27D****Figure 27E**

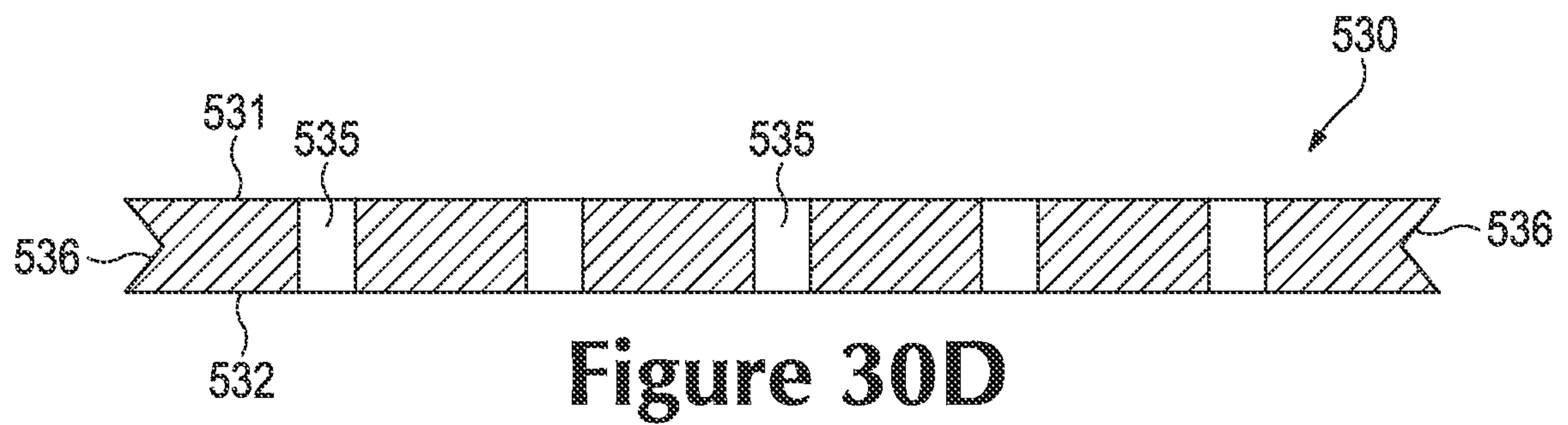
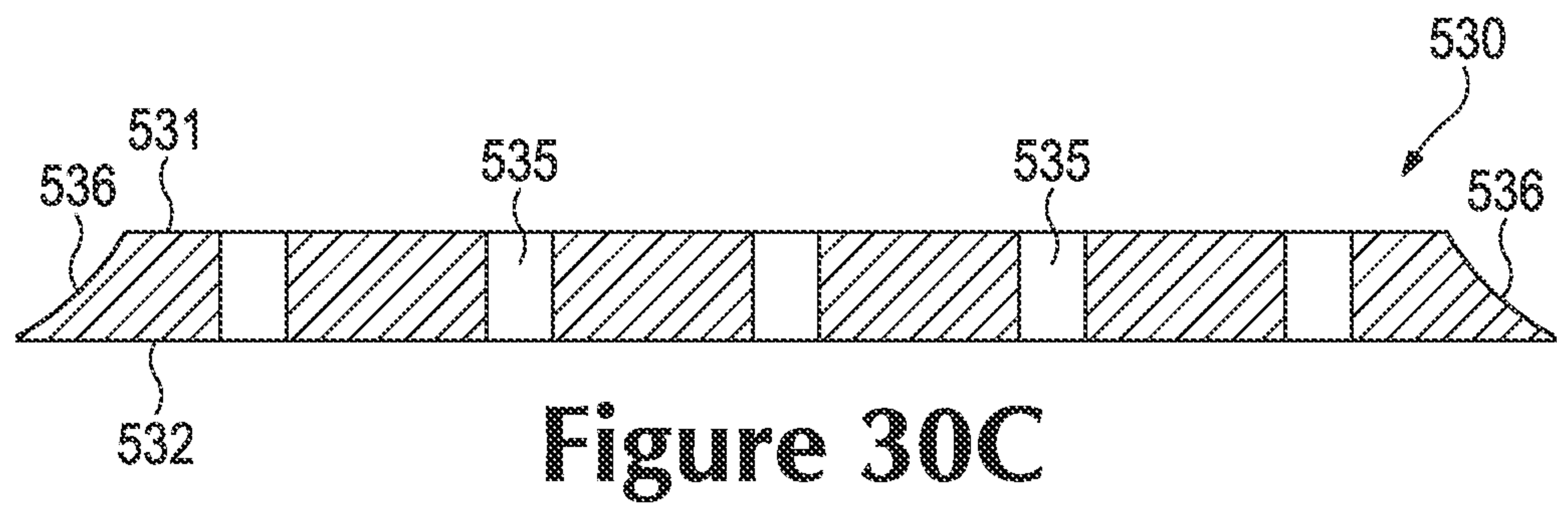
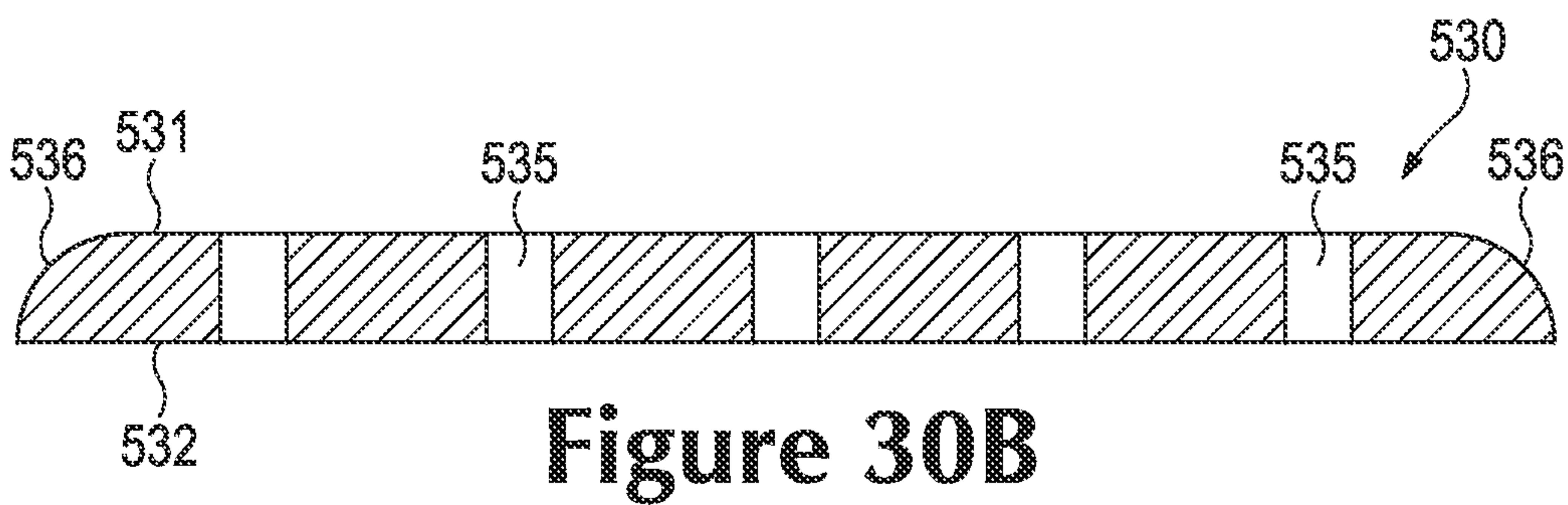
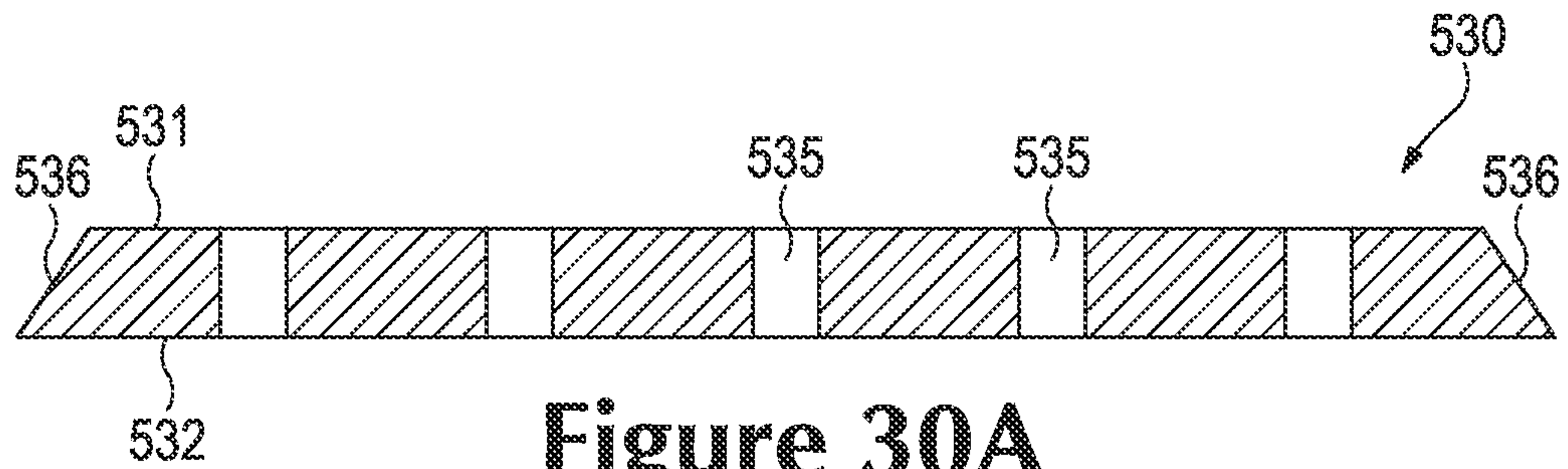
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**Figure 28**

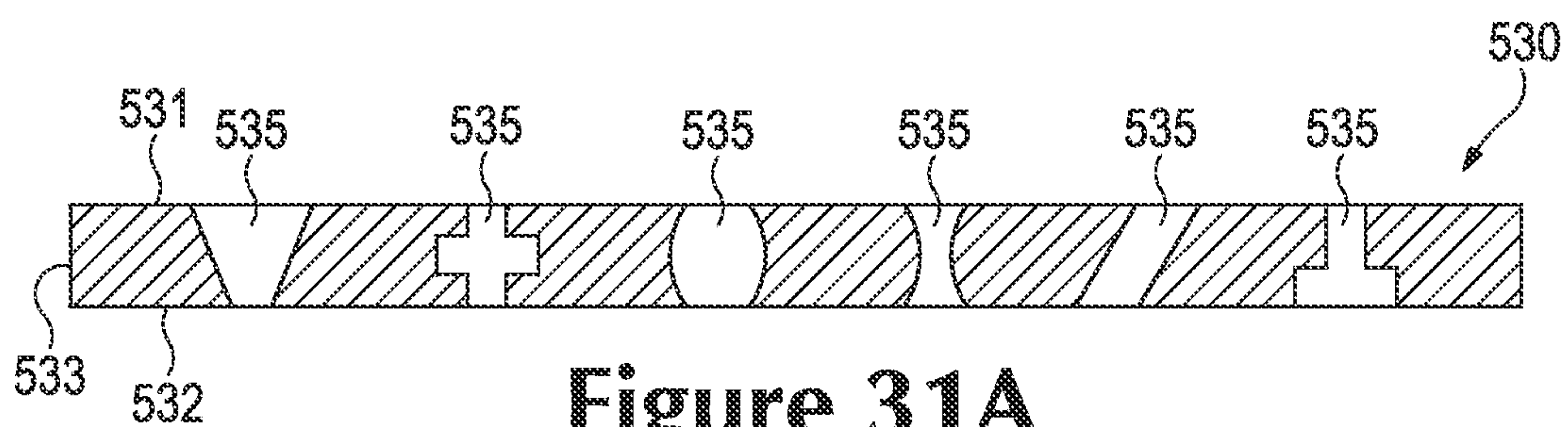
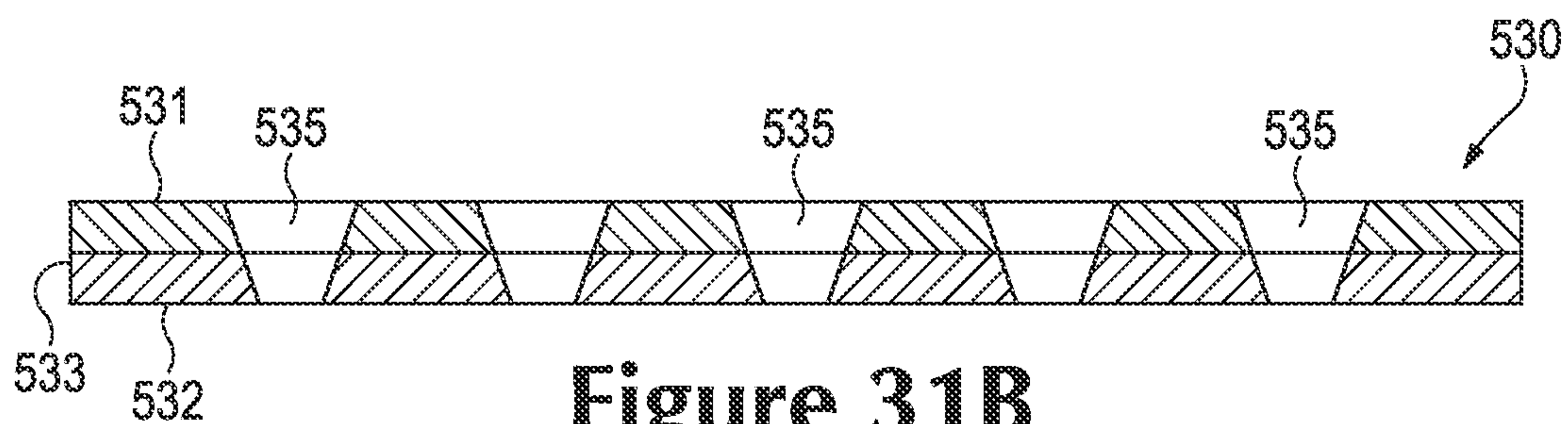
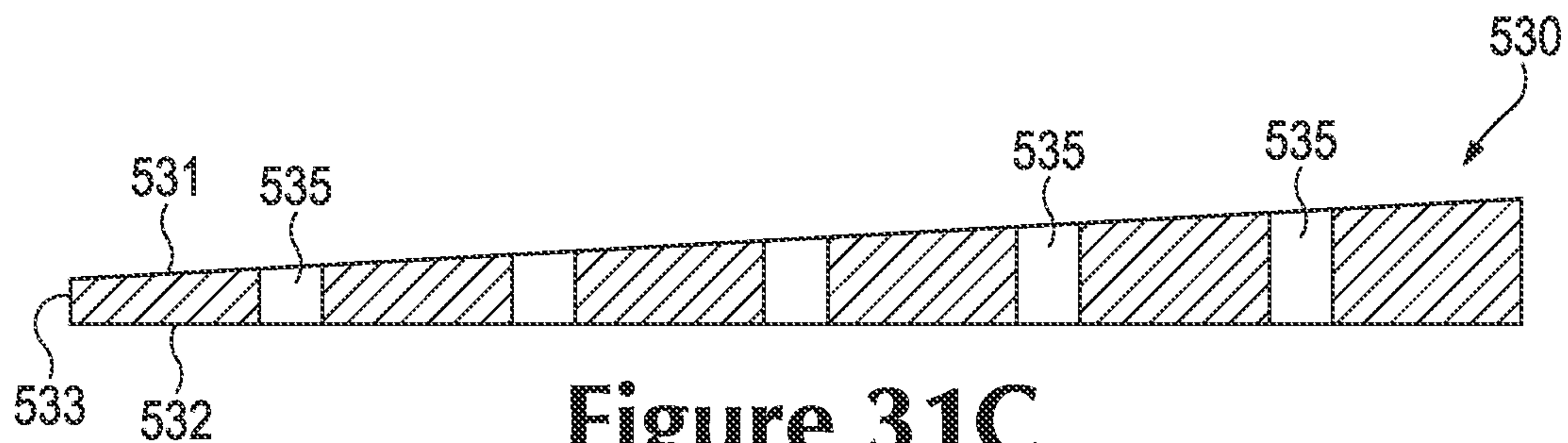
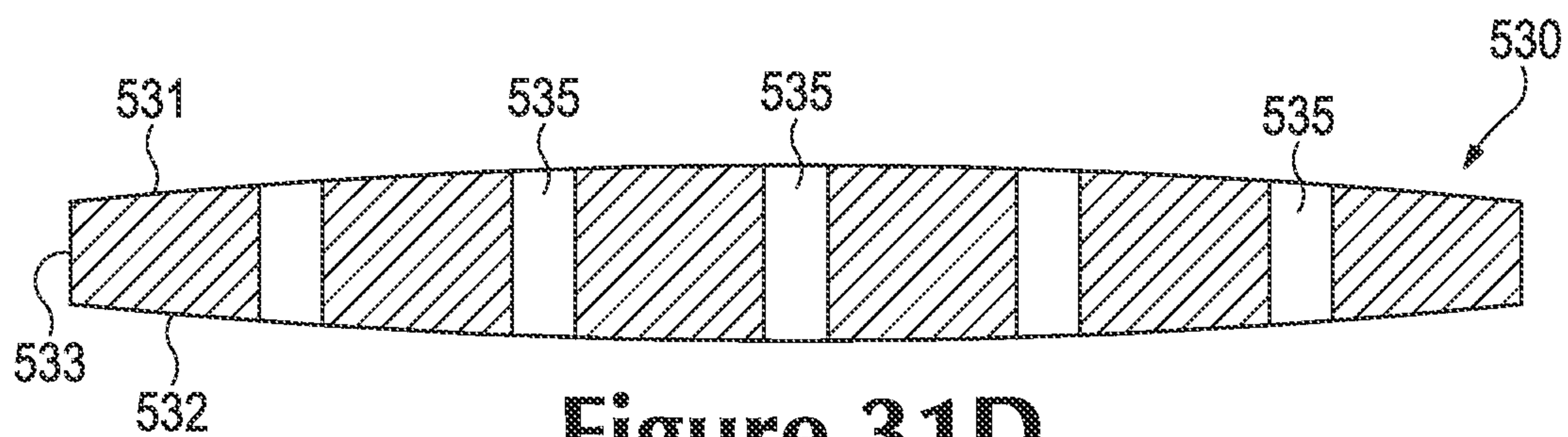
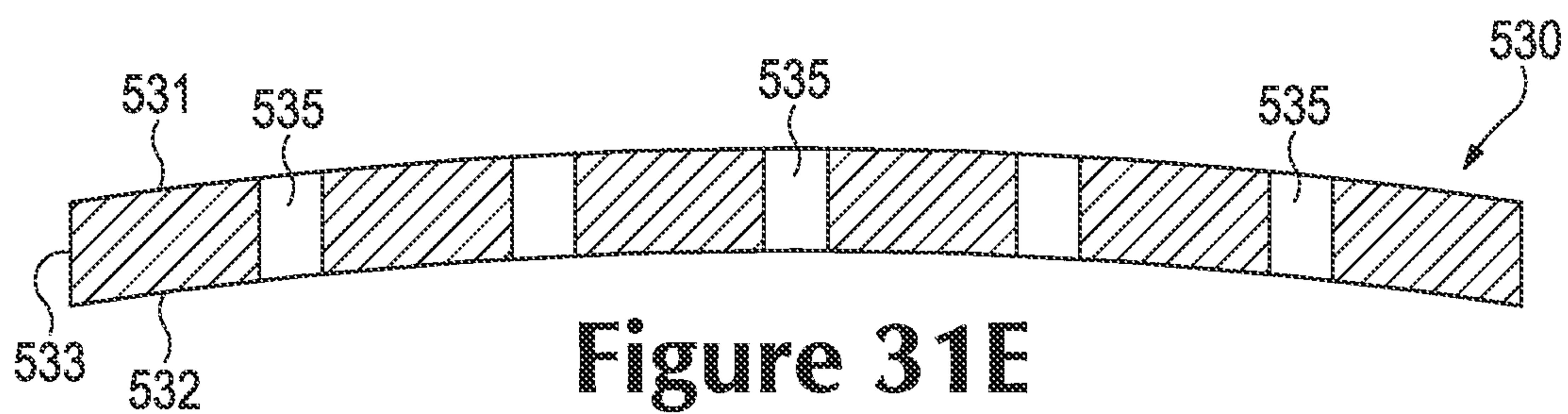
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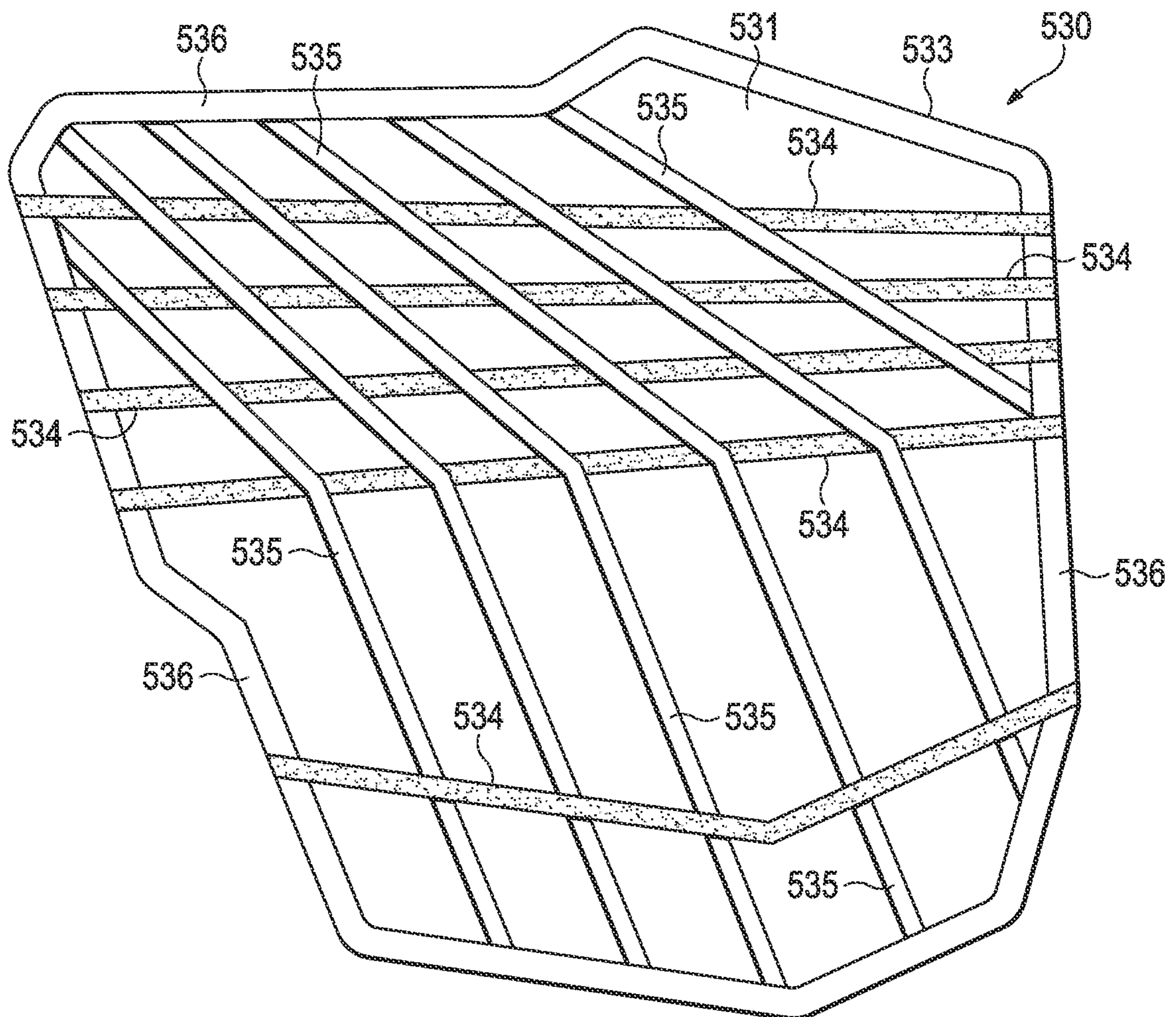
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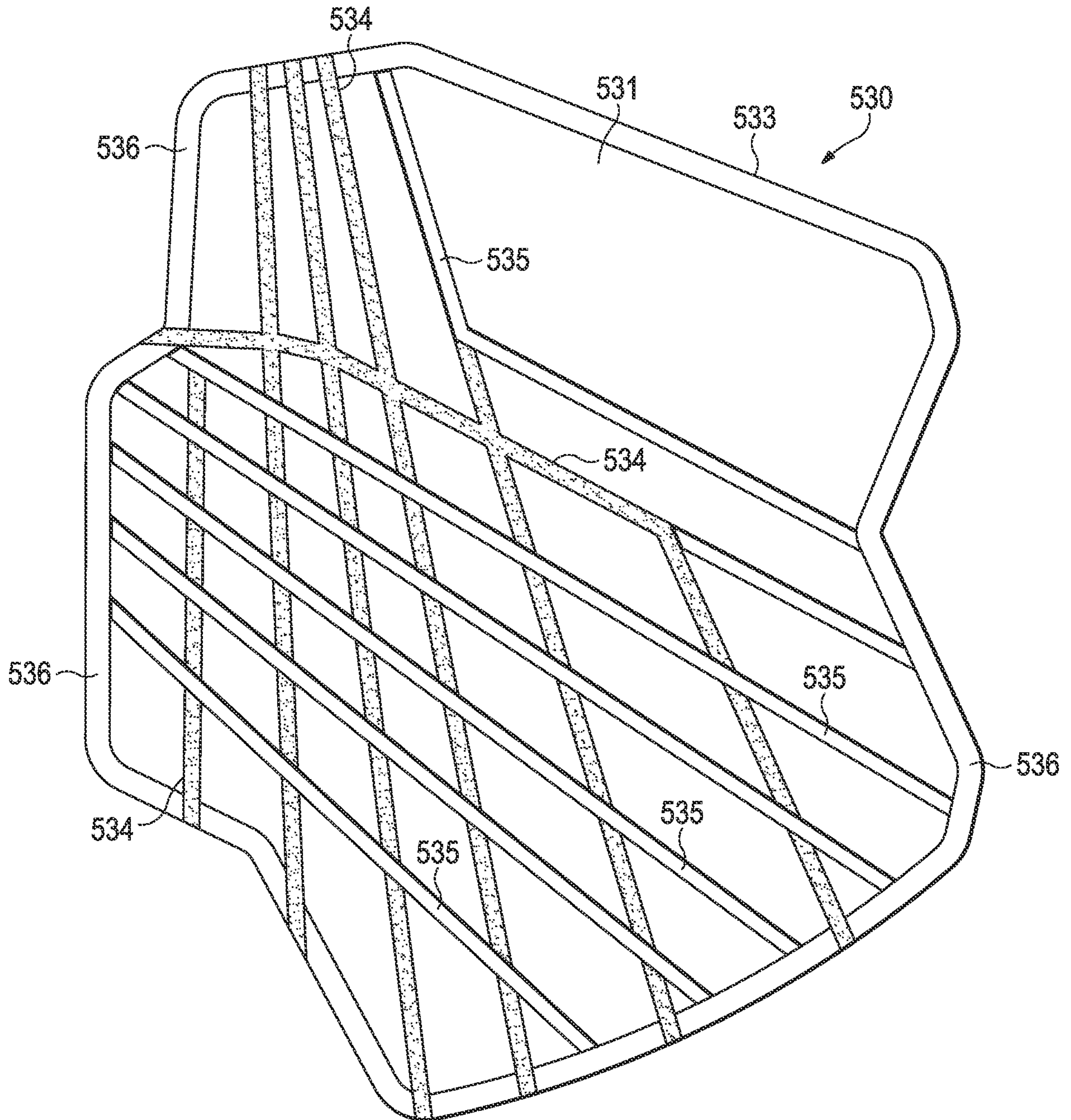
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**Figure 31A****Figure 31B****Figure 31C****Figure 31D****Figure 31E**

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**Figure 32**

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**Figure 33**

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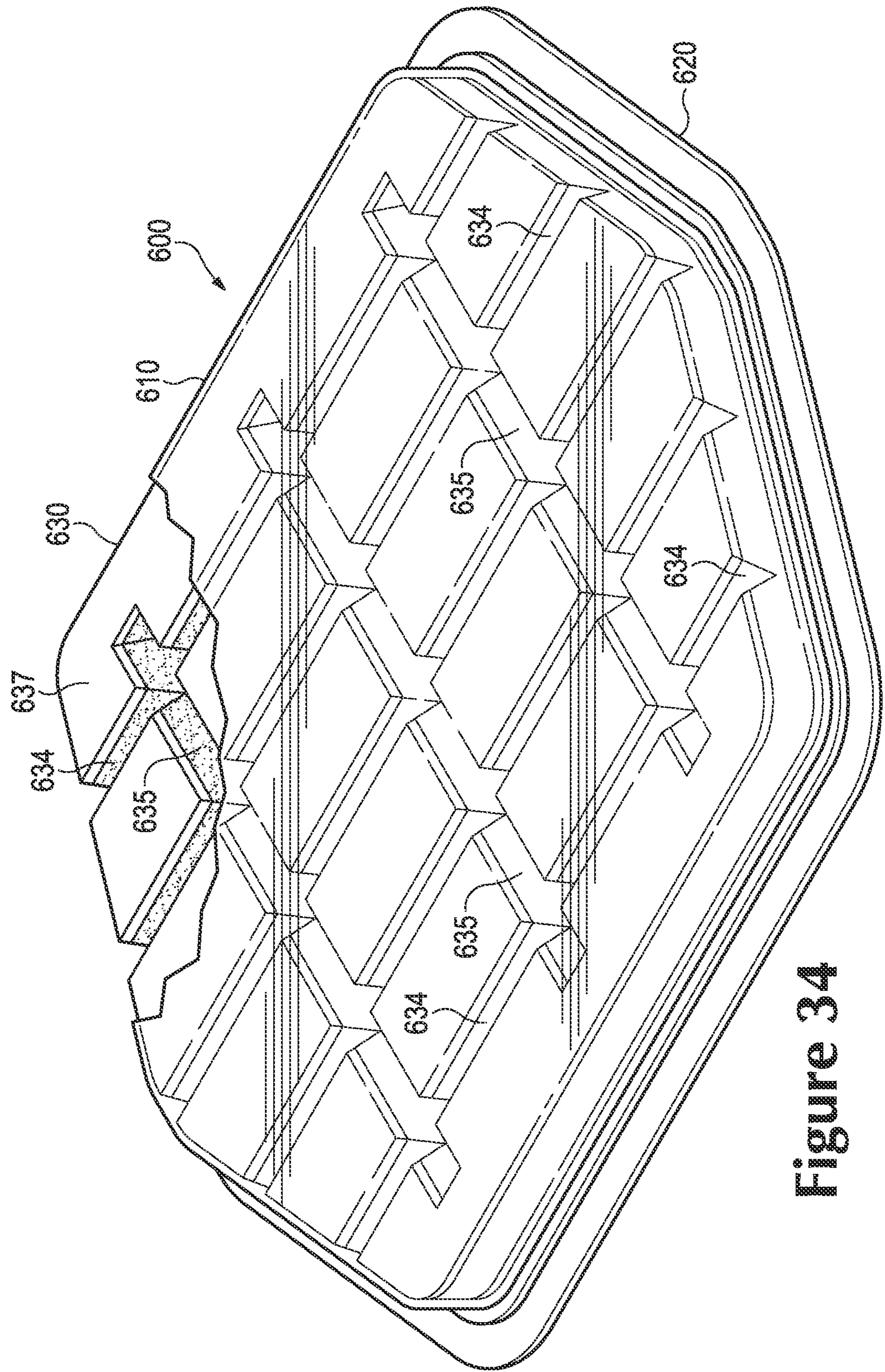
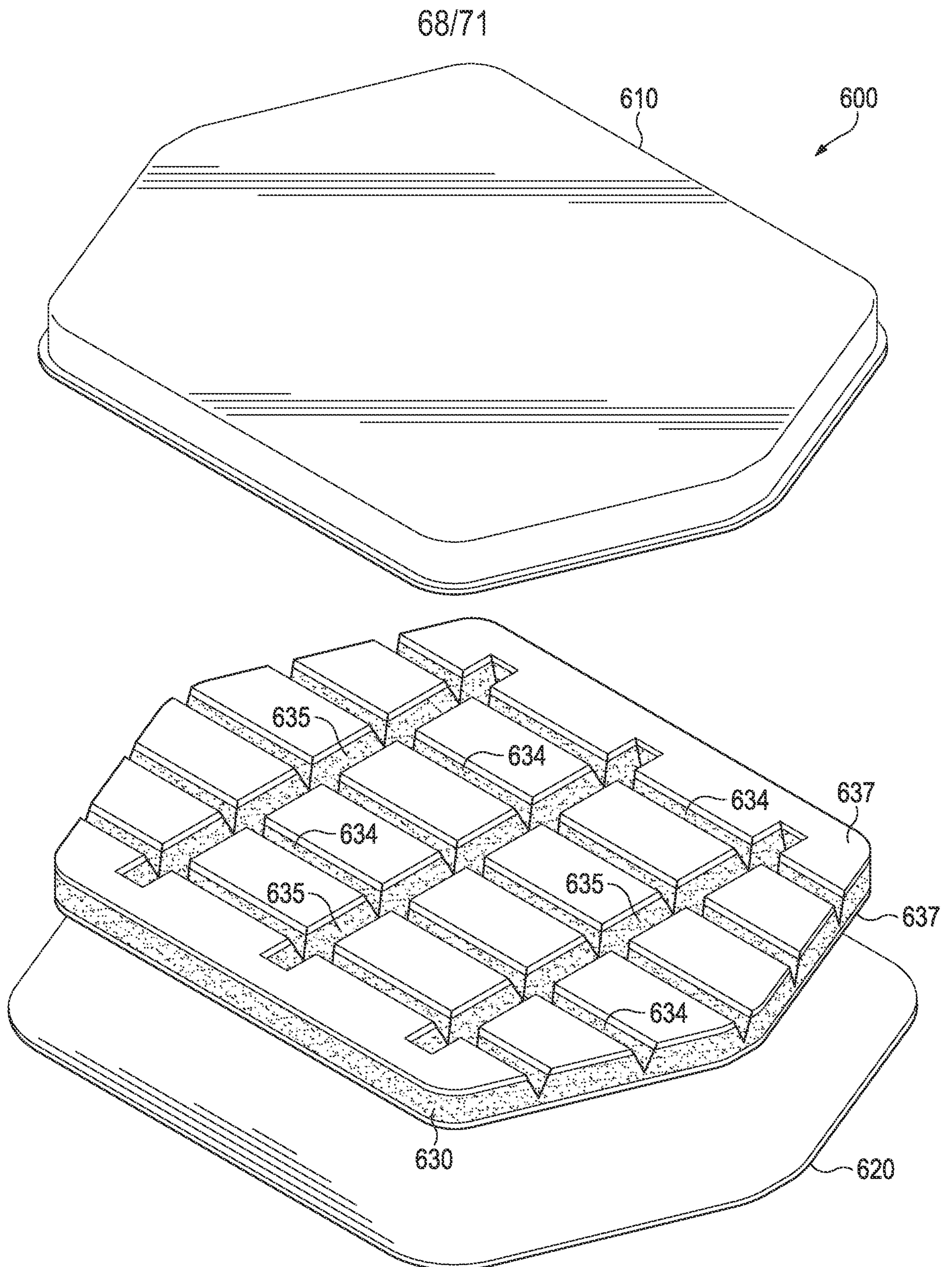
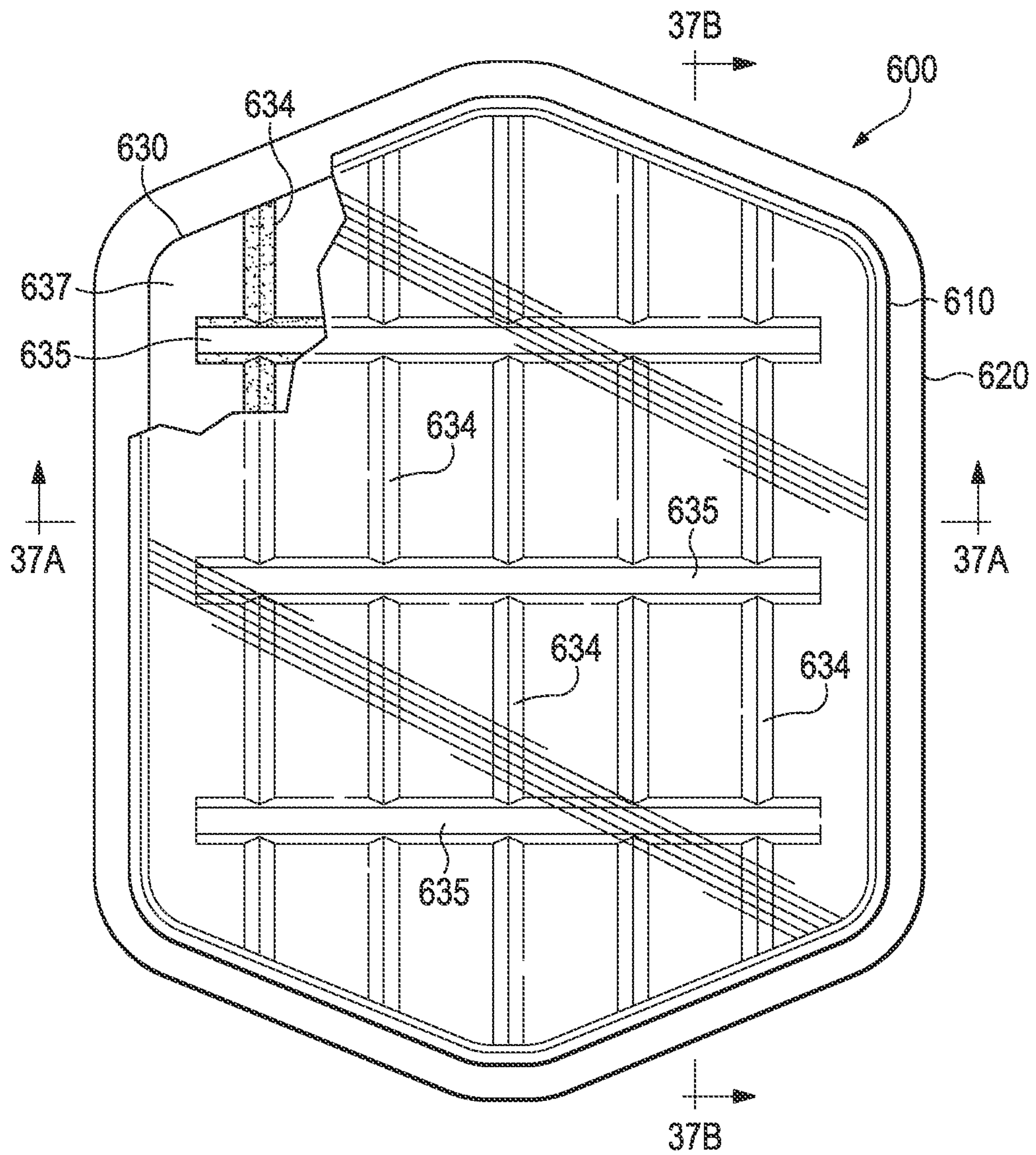
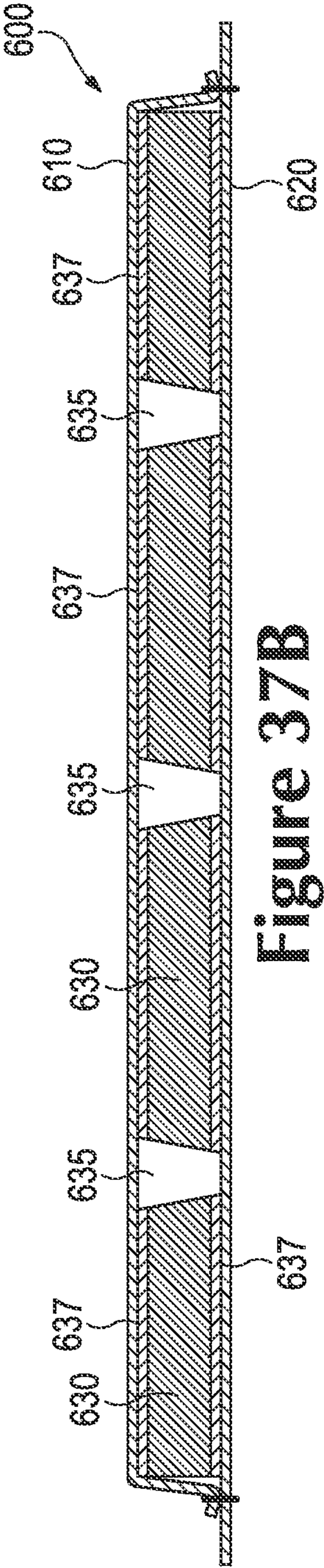
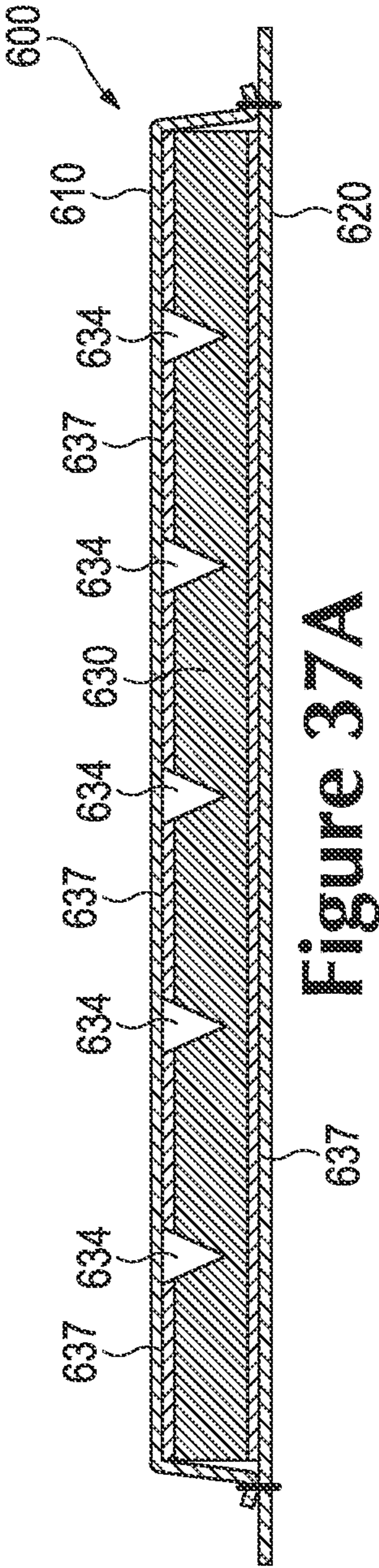


Figure 34

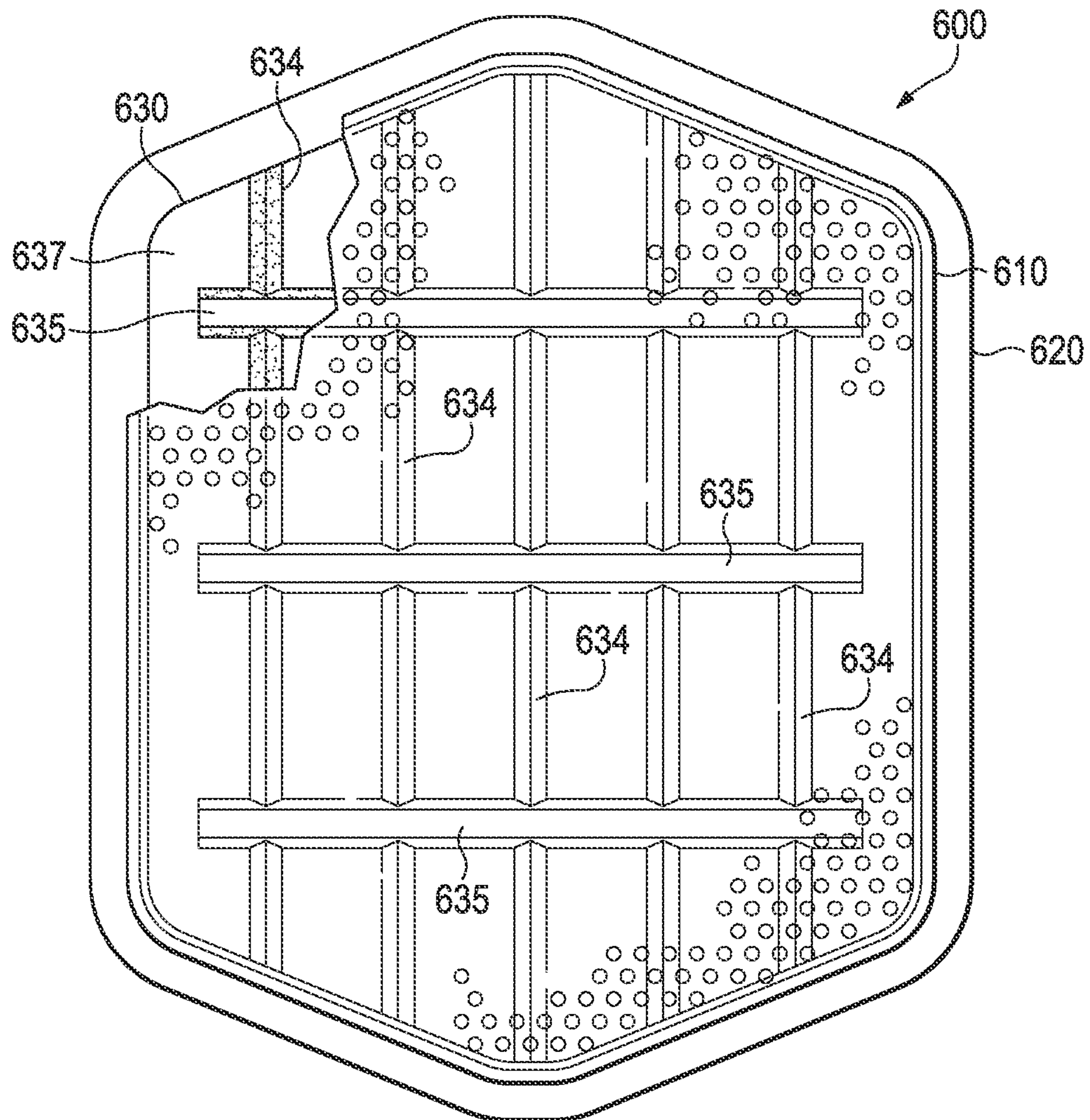
**Figure 35**

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**Figure 36**



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**Figure 38**

