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(54) THERMOFORM CUSHIONS USING A SERIES OF COMPLEX SHAPES

(57) A product cushioning device for protecting a shock sensitive product, said product cushioning device comprising wall structure that defines a product receiving area, the product receiving area extending from a product receiving area opening to a product receiving area base, the wall structure comprising a plurality of product contact portions. The product cushioning device includes a tapered cushion disposed about a portion of the product receiving area to absorb impact in tri-axial vector directions. The tapered cushion comprises a tapered inner wall, a cushion outer wall that is curved and tapered and a compressible channel structure connecting between the tapered inner wall and the cushion outer wall.

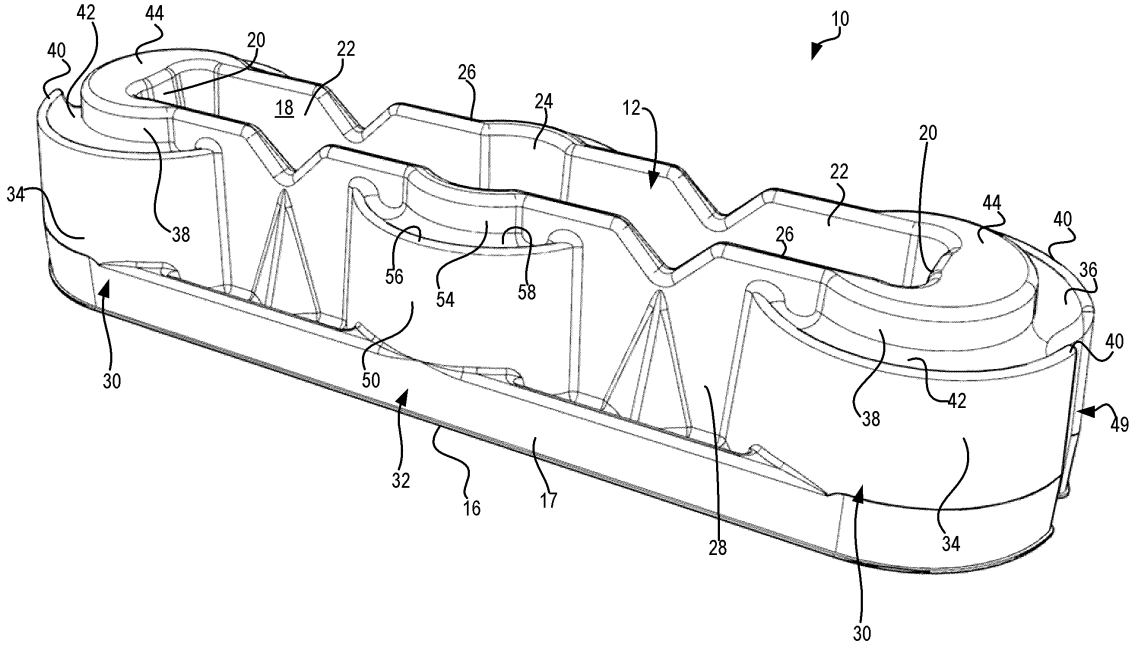

FIG. 1

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Description

RELATED APPLICATIONS

[0001] The present application claims the benefit of priority under 35 U.S.C. § 119(e) to United States Provisional Application No. 63/591,425, entitled "THERMOFORM CUSHIONS USING A SERIES OF COMPLEX SHAPES," filed October 18, 2023, and United States Provisional Application No. 63/619,253, entitled "THERMOFORM CUSHIONS USING A SERIES OF COMPLEX SHAPES," filed January 9, 2024, both of which are hereby fully incorporated by reference herein for all purposes.

BACKGROUND

[0002] Product cushioning devices are used to protect shock sensitive equipment during shipping. Some product cushioning devices are formed by thermoforming, which is a multi-step process typically involving heating a plastic sheet, forming the plastic sheet using a mold, cooling the plastic sheet, and trimming excess material from the completed plastic part. Some existing thermoform cushions in the market segment use relatively simple shapes to dispense energy. Design parameters, such as the shape of the completed part, material selected, and thickness of the material, affect the ability of the completed part to withstand and distribute shock forces. Increased shock handling capability typically requires more material, which increases both material and shipping costs.

[0003] There is a desire for product cushioning devices that use less material than conventional thermoform cushions while providing similar or superior shock handling characteristics.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] The drawings accompanying and forming part of this specification are included to depict certain aspects of the disclosure. It should be noted that the features illustrated in the drawings are not necessarily drawn to scale. A more complete understanding of the disclosure and the advantages thereof may be acquired by referring to the following description, taken in conjunction with the accompanying drawings in which like reference numbers indicate like features.

FIG. 1 is an isometric view of one embodiment of a product cushioning device.

FIG. 2 is an elevated view of one embodiment of a product cushioning device.

FIG. 3 is a front view of one embodiment of a product cushioning device.

FIG. 4 is a rear view of one embodiment of a product cushioning device.

FIG. 5 is a top view of one embodiment of a product cushioning device in more detail.

FIG. 6 illustrates a first cross-section of one embodiment of a product cushioning device.

FIG. 7 illustrates a second cross-section of one embodiment of a product cushioning device.

FIG. 8 is a diagrammatic representation of one embodiment of product cushioning devices for a product being packed in external packaging.

FIG. 9 illustrates another embodiment of a product cushioning device that includes a perimeter flange.

FIG. 10 illustrates another embodiment of a product cushioning device that includes engineered ribs.

DETAILED DESCRIPTION

[0005] Embodiments and the various features and advantageous details thereof are explained more fully with reference to the non-limiting embodiments that are illustrated in the accompanying drawings and detailed in the following description. Descriptions of well-known starting materials, processing techniques, components and equipment are omitted so as not to unnecessarily obscure the embodiments in detail. It should be understood, however, that the detailed description and the specific examples are given by way of illustration only and not by way of limitation. Various substitutions, modifications, additions and/or rearrangements within the spirit and/or scope of the underlying inventive concept will become apparent to those skilled in the art from this disclosure.

[0006] Embodiments disclosed herein provide product cushioning devices that allow desired shock handling characteristics to be achieved while requiring less material than existing thermoform cushion designs. Embodiments of product cushioning devices according to the present disclosure, on the other hand, use a series of complex shapes in the structure to absorb impact in triaxial vector directions.

[0007] Product cushioning of a thermoformed formed sheet of plastic material is dependent on thickness, density and crosslinking., The compression strength of the molded unitary structure and thereby its ability withstand shock forces may vary as a function of the thickness and density of the plastic thermoformable sheet plastic material, from which the molded unitary product cushioning structure has been thermoformed. The performance of the thermoformed plastic sheet correlates to the original plastic sheet material thickness and cross-linking of the plastic. The correlation of weight of the device shall increase the thermoform material thickness and density.

[0008] One embodiment of a product cushioning device for protecting a shock sensitive product comprises a wall structure that defines a product receiving area. The product receiving area extends from an opening to the product receiving area to a product receiving area base. The wall structure comprises product contact portions to contact and support the product during use. The product cushioning device includes a tapered cushion disposed about a portion of the product receiving area to absorb impact in tri-axial vector directions. The tapered cushion may have a plurality of shock value zones.

[0009] According to one embodiment, the tapered cushion comprises a tapered inner wall that is proximate to the product receiving area and extends from a first inner wall end proximate to the product receiving area base to a second inner wall end distal from the product receiving area base. The tapered cushion further includes a cushion outer wall that is curved and tapered. A compressible channel structure connects between the tapered inner wall and the cushion outer wall.

[0010] According to one embodiment, the compressible channel structure has a recurve shape. For example, the compressible channel structure may include a channel inner wall connected to the second inner wall end by a first curved ridge, a curved channel base, and a second curved ridge connecting the curved channel base to the cushion outer wall.

[0011] In one embodiment, the wall structure comprises a curved portion that spans between adjacent product contact portions from the plurality of product contact portions, wherein the tapered inner wall of the tapered cushion comprises the curved portion. The cushion outer wall may span between the adjacent product contact portions.

[0012] According to one embodiment, the cushion inner wall and the cushion outer wall are defined by cones having apexes on a common axis. In an even more particular embodiments, the cones taper in opposite directions relative the common axis so that the tapered inner wall tapers toward the common axis and the cushion outer wall tapers away from the common axis.

[0013] One embodiment of a product cushioning device for protecting a shock sensitive product comprises a wall structure that defines a product receiving area. The product receiving area extends from a product receiving area opening for receiving a product to a product receiving cavity base. The product cushioning device further comprises a series of inverted tapered cushions connected between the product contact sections. According to one embodiment, each of the inverted tapered cushions comprises an inner wall proximate to the product receiving area and an outer wall. The inner wall extends from an inner wall first end distal from the product receiving area base to an inner wall second end proximate to the product receiving area base. The inner wall converges toward a first axis. The outer wall extends from an outer wall first end to an outer wall second end. The outer wall is tapered toward a second axis. In some embodiments, the first axis and the second axis of a tapered cushion are the same. A flexible, resilient channel structure connects between the inner wall to the outer wall.

[0014] Product cushioning devices may include a variety of other features. For example, some embodiments of product cushioning devices comprise one or more of: the product cushioning device is formed from a unitary sheet of thermoform material; the thermoform material is High Density Polyethylene (HDPE); the thermoform material is a molded fiber; the product cushioning device is formed as an end cap; the product cushioning device includes offsets to offset the product cushioning device from a wall of a surrounding package; noses of the tapered cushions provide the offsets; the noses of the tapered cushions are spherical; the product cushioning device comprises a base portion to contact the surrounding packaging; the product cushioning device is nestable with other product cushioning devices having the same form factor; the channel between a cushion inner wall and a cushion outer wall is a conical curved channel; the channel has a channel base that is spaced from the first end of the inner wall and the first end of the outer wall; the channel has a depth such that the channel base is located at the outer third of the inner wall; the product cushioning device comprises structural ribs.

[0015] Product packaging for shock sensitive products often includes cushioning devices to protect the products if they are dropped or mishandled during shipping. Reference will now be made to FIGS. 1 to 7, which illustrate various views of one embodiment of a product cushioning device 10. More particularly, FIG. 1 is an isometric view of product cushioning device 10, FIG. 2 is an elevated view of product cushioning device 10, FIG. 3 is a front view of product cushioning device 10, FIG. 4 is rear view of product cushioning device 10, FIG. 5 is a top view of product cushioning device 10, FIG. 6 is a cross-section A-A of product cushioning device 10 and FIG. 7 is a cross-section B-B of product cushioning device 10.

[0016] Product cushioning device 10 is formed from a sheet of thermoform plastic or other resilient material to provide a wall structure that defines a product receiving area 12 for receiving and supporting a product. The walls of product cushioning device 10 can be tapered at a draft angle. For example, various walls are angled, according to one embodiment, at a draft angle that allows release from a mold. In even more particular embodiments, the draft angle is from approximately 4 degrees to approximately 6 degrees. Other embodiments may use other draft angles to facilitate removal of the product cushioning device from a mold and to allow nesting of product cushioning devices. Product cushioning device 10 is, according to one embodiment, nestable with other product cushioning devices of the same design.

[0017] Product cushioning device 10 is formed as an end cap that fits over the end of a product to be supported and protected. To this end, the wall structure of product cushioning device 10 defines a product receiving area 12

to receive the end of the product. Product receiving area 12 is sized based on the product to be supported. By way of example, but not limitation, product receiving area 12 may be sized for a 1 RU computer system or a 2 RU computer system. The product's depth of insertion may be limited by a base 14 (e.g., a rear wall).

[0018] Product receiving area is open to a front side of product cushioning device 10 to receive the end of the product. When placed in surrounding packaging, the opposite side may abut the surrounding packaging. For example, when placed in an outer container, rear edge 16 may contact the walls of the container. According to one embodiment, base 14 of product receiving area 12 is offset from rear edge 16 such that there will be a gap between base 14 and the surrounding container. A portion 17 proximate rear edge 16 has a generally rectangular outer profile such that product cushioning device 10 abuts the adjacent container walls along portion 17.

[0019] Product receiving area 12 is bounded by a pair of opposing continuous sidewalls 18 (e.g., product receiving area top and bottom walls) and end walls 20 and terminates at product receiving area base 14. Each sidewall 18 and end wall 20 extends from a respective first end proximate to the product receiving area base 14 forward to a respective second end distal from the product receiving area base 14. In one embodiment, sidewalls 18 and end walls 20 are portions of a continuous wall. While product cushioning device 10 includes sidewalls 18 and end walls 20, other embodiments may omit one or more of the walls. As one example, some implementations may not include end walls 20.

[0020] Thus, in the embodiment illustrated, sidewalls 18, end walls 20 and base 14 define product receiving area 12. Product receiving area sidewalls 18 include product contact portions 22 separated by curved portions 24. The product contact portions 22 of sidewalls 18 and end walls 20 snuggly contact the outer perimeter of the product while the curved portions 24 form curved recesses that extend away from product receiving area 12. Sidewalls 18 are connected to outer walls 28 by ridges 26.

[0021] According to one embodiment, sidewalls 18 taper toward each other and the end walls 20 taper toward each other moving from the front opening toward base 14. Thus, product receiving area 12 has a generally trapezoidal prism shape. In other embodiments, product receiving area 12 has a generally truncated triangular prism shape (either sidewalls 18 or end walls 20 taper toward each other) or another shape. In any case, should the product experience an impact that causes the product to move deeper into the product receiving area (e.g., an end force F(end) in FIG. 5), the tapered walls deflect apart to absorb the force.

[0022] The wall structure of product cushioning device 10 includes curved offsets 19 at the transitions between sidewalls 18 and end walls 20 so that the walls are offset from the corners of the product. This results in the load bearing being on the flat surfaces of the product during normal use and avoids stress concentrations at the corners. The offsets help avoid shock in a corner drop event from being transferred directly to the corner of the product. Instead, the shock will be distributed by the curved offsets to the adjacent flat product contact portions 22 and end walls 20, which better disperse the shock.

[0023] The wall structure defines a series of tapered cushions, each tapered cushion is disposed about a portion of the product receiving area and adapted to absorb impact in tri-axial vector directions to protect the product being shipped. Morre particularly, product cushioning device 10 includes end tapered cushions 30 proximate to the ends of product receiving area 12 and an intermediate tapered cushion 32 between the end tapered cushions 30. Other embodiments may include fewer tapered cushions or more tapered cushions. For example, a cushioning device may include additional intermediate tapered cushions 32 (e.g., in a tessellated pattern, for example) to further distribute shock along the structure. As another example, a cushioning device may omit one or more of the end tapered cushions.

[0024] Each end tapered cushion 30 comprises tapered cushion inner walls formed by the end portions of sidewalls 18 and the respective end wall 20. According to one embodiment, tapered cushions 30 are inverted in that the tapered cushion inner walls diverge moving away from base 14 toward the opening of the product receiving area 12. In some embodiments, straight portions of sidewalls 18 or end walls 20 may defined by a trapezoidal prism, a truncated triangular prism, or other shape such that the tapered cushion inner walls converge moving along the respective axis 46 from the opening to product receiving area 12 toward the rear of product receiving area 12. In another embodiment, the cushion inner walls of tapered cushions 30 are curved. For example, the walls at the end portion of product receiving area 12 may be defined by a cone that converges toward an apex on the respective axis 46.

[0025] Each end tapered cushion 30 also comprises cushion outer walls 34, channel outer walls 36 and a channel inner wall 38. Each cushion outer wall 34 extends from a first outer wall end that is proximate to portion 17 to a second end distal from portion 17 and is connected at the second end to a channel outer wall 36 by a ridge 40. Each channel outer wall 36 is connected to channel inner wall 38 by a channel base 42 that forms a channel therebetween. Channel inner walls 38 are connected to respective tapered cushion inner walls (end walls 20 and sidewalls 18) by a respective connecting wall portion 44 (e.g., a ridge or a face) that extends between them. In some embodiments, connecting wall portion 44 includes a portion of ridges 26.

[0026] Cushion outer walls 34 of tapered cushions 30 have shaped geometries that converge toward respective axes 46. In the illustrated embodiment, for example, cushion outer walls 34 of each tapered cushion 30 are conical wall portions defined by a cone that converges, moving rear-to-front, to an apex on the corresponding

axis 46 (i.e., an apex that is to the front of product cushioning device 10 on the projected axis 46). Similarly, channel outer walls 36 or channel inner wall 38 of each tapered cushion 30 may be defined by respective cones or other shapes that converge to corresponding apexes on the respective axis 46. In one embodiment, channel inner wall 38 diverges away from the respective axis 46 and channel outer walls 36 diverge away from the respective axis 46 moving front-to-rear. In an even more particular embodiment, channel inner wall 38, according to one embodiment, is generally parallel to the corresponding cushion outer wall 34.

[0027] Thus, tapered cushion outer walls 34 and the tapered cushion inner walls of each tapered cushion 30 are separated by a channel, with the channel being defined by a respective flexible, resilient channel structure comprising channel outer walls 36, channel inner wall 38 wall and channel base 42 that spans between the channel inner wall 38 and channel outer walls 36. Ridge 40, channel base 42, and connecting wall portion 44 of each tapered cushion 30 function as a spring to absorb shock in multiple vector axes. According to one embodiment, the channel structures of tapered cushions 30 may have a recurve shape. The width and depth of the channel and other aspects of the recurve shape can be selected to result in desired shock handling characteristics.

[0028] In the event of an impact that starts to crush a tapered cushion 30 (i.e., a shock with a force component on cushion outer wall 34 that is normal to axis 46) ridge 40 compresses/deflects to absorb an initial amount of force. A larger shock can be absorbed by compression/deflection of ridge 40 and channel base 42. An even larger shock can be absorbed by compression/deflection of ridge 40, channel base 42, and wall portion 44. Thus, each tapered cushion 30 has multiple shock value zones. The shock handling characteristics of a tapered cushion may vary as a function of the three-dimensional shape of the tapered cushion. In some embodiments, the tapered cushions 30 are configured so that deflection of the outer cushion wall 34 and ridge 40 is sufficient to handle common low-level shocks, such as experienced from vibration during shipping.

[0029] Product cushioning device 10 further comprises molded features 48 at a nose of the inverted tapered shape. In the illustrated embodiment, molded features 48 are elliptical domes that extend away from product receiving area 12. Features 48 provide additional areas of deflection to absorb impacts in multiple vector axes.

[0030] End tapered cushions 30 of product cushioning device 10 include shaped breakaways 49 running from the first side (front side) of product cushioning device 10 to a second side (rear side) of product cushioning device 10, which in the illustrated embodiment are formed as cylindrical cutaways at the ends of the of product cushioning devices. The breakaways 49 provide additional areas of deflection that allow cushions 30 to more easily compress when end tapered cushions 30 experience a crushing force (F(crush) in FIG. 3) and rebound when the force is released.

[0031] Intermediate tapered cushion 32 comprises tapered cushion inner walls (e.g., curved portions 24 of sidewalls 18), cushion outer walls 50, channel outer walls 52 and channel inner walls 54. The tapered cushion inner walls (curved portions 24) span between adjacent product contact portions 22 of the wall structure and tapered cushion outer walls 50 span between sections of outer walls 28. Each cushion outer wall 50 extends from a first outer wall end that is proximate to portion 17 to a second end that is distal from portion 17 and is connected at the second end to a channel outer wall 52 by a ridge 56. Each channel outer wall 52 is connected to a channel inner wall 54 by a channel base 58 that forms a channel therebetween. Channel inner walls 54 are connected to respective cushion inner walls (curved portions 24) by ridges 26.

[0032] Tapered cushion inner walls (curved portions 24) of tapered cushion 32 have shaped geometries that converge toward a respective axis 60. In the illustrated embodiment, for example, the tapered cushion inner walls of tapered cushion 32 are defined by a corresponding cone that converges to an apex on a first axis 60. In the illustrated embodiment, tapered cushion 32 is inverted in that the base of the converging shape that defines the tapered cushion inner walls is distal from the base (e.g., base 14) of the product receiving area 12.

[0033] Cushion outer walls 50 of a tapered cushion 32 have shaped geometries that converge toward respective second axes. In the illustrated embodiment, cushion outer walls 50 are curved. For example, cushion outer walls 50 are, according to one embodiment, defined by cones that converge to corresponding apexes on the second axes. In an even more particular embodiment, the cushion outer walls 50 of tapered cushion 32 on either side of product receiving area 12 are defined by the same cone.

[0034] Cushion outer walls 50 of a tapered cushion 32, in some embodiments, are formed about the same axis 60 as the tapered cushion inner walls-that is, the first and second axes of tapered cushion 32 are the same axis 60. For example, curved portions 24 and cushion outer walls 50 may be formed as portions of cones that have different apexes on axis 60. In some embodiments, the cushion outer walls 50 are tapered in the opposite direction from the cushion inner walls. For example, outer walls 50 and curved portions 24 may be defined by cones that have apexes on projected axis 60 but on opposite sides of product cushioning device 10 such that cushion outer walls 50 diverge moving from front to rear along axis 60 and curved portion 24 may converge moving front to rear along axis 60.

[0035] Tapered cushion outer walls 50 and the tapered cushion inner walls (e.g., curved portions 24) of a tapered cushion 32 are separated by channels with the channels being defined by the respective channel outer walls 52, channel inner walls 54 wall and channel bases 58 that

span between the channel inner walls 54 and channel outer walls 52. Channel inner wall 38, according to one embodiment, is generally parallel to the corresponding cushion outer wall 34. Ridge 56, channel base 58, and ridge 26 can be adapted to act as a spring to absorb shock in multiple vector axes. For example, the channel structures of tapered cushion 32 may have a recurve shape. The width and depth of the channel and other aspects of the recurve shape can be selected to result in desired shock handling characteristics.

[0036] In the event of an impact that starts to crush a tapered cushion 32 (i.e., a shock with a force component on cushion outer wall 50 that is normal to axis 60) ridge 56 compresses/deflects to absorb an initial amount of force. A larger shock can be absorbed by compression/deflection of ridges 56 and channel bases 58. An even larger shock can be absorbed by compression/deflection of ridges 56, channel bases 58, and ridges 26. Thus, tapered cushion 32 has multiple shock value zones. The shock handling characteristics of a tapered cushion may vary as a function of the three-dimensional shape of the tapered cushion. In some embodiments, the tapered cushion 32 is configured so that deflection of the outer cushion walls 50 and ridges 56 is sufficient to handle common low-level shocks, such as experienced from vibration during shipping.

[0037] Product cushioning device 10 further comprises molded feature 62 at a nose of the inverted tapered shape. In the illustrated embodiment, molded feature 62 is a domed wall section that extends away from product receiving area 12. Feature 62 provides an additional area of deflection to absorb impacts in multiple vector axes.

[0038] Should the product experience an impact that causes the product to move deeper into the product receiving area (e.g., an end force F(end) in FIG. 5), the tapered shapes of tapered cushions 30, 32 and recurved channels allow the tapered cushions to flex outward in drop events to absorb shock. Further, features 48 and feature 62 can flex when, for example, a product in product cushioning device 10 pushes against base 14 in a drop event, thus absorbing energy from the drop event. Moreover, in some embodiments, features 48 and feature 62 act as offsets to support product receiving area base away from the inner surface of the container.

[0039] Further, product cushioning device 10 includes triangular breakaways 70 between cushions where the apexes of the triangular breakaways transition into pyramid shaped sections 72. These features provide stress concentrators when the product cushioning device 10 experiences side impact forces (F(side) in FIG. 5). More particularly, the triangular breakaways 70 can flex (e.g., the angle between edges 71 can increase) to create a point load and triangular pyramids 72 can deflect (collapse or compress along edge 73) under the point load to both absorb energy and allow adjacent tapered cushions to further compress or flex.

[0040] With reference to FIG. 6, cross-section A-A of FIG. 3 is illustrated. The inner wall (e.g. curved portion 24 of sidewall 18) and outer wall 50 of a tapered cushion 32 are spaced by a channel 75 defined by a channel inner wall 54, a channel outer wall 52, and a channel base 58. According to one embodiment, channel 75 is a conical curved channel. Channel inner wall 54, according to one embodiment, is generally parallel to the corresponding cushion outer wall 50 and is connected to the cushion inner wall (e.g., curbed portion) 24 by a corresponding ridge 26 or face. Channel outer wall 52, according to one embodiment, is connected to the cushion outer wall 50 at a corresponding ridge 56 or face. Channel base 58 spans between the channel inner wall 54 and the channel outer wall 52. In some embodiments, the peak height (distance) of ridge 56 from the level of the product receiving area base (e.g., base 14) is within 20% of the peak height 80 of ridge 26 from the product receiving area base.

[0041] Shock modeling and package drop testing reveals that the recurve shape results in multiple shock value zones. In one example, the shock of a light drop (<20 G) will be absorbed by compression/deflection of ridge 56, a larger shock (21-60 G) will be absorbed by compression/deflection of ridge 56 and channel base 58, and larger shocks (61-90 G) will be absorbed by compression/deflection of ridge 56, channel base 58, and ridge 26. Changing the width and depth of the channel results in different shock handling characteristics.

[0042] According to one embodiment, ridge 26, channel base 58, and ridge 56 are curved to create a recurve shape. In a resilient material, the ability of ridge 26, channel base 58, and ridge 56 to deflect/compress allows the channel to act as a spring to control shock impulses and cushion the product. The recurve shape can, for example, control displacement during a drop event to absorb energy. The curves of ridge 26, base 58, ridge 56, the depth and width of channel 75 can be selected to achieve desired shock handling characteristics. In one embodiment, base 58 and channel outer wall 52 are formed from a continuous curve having a radius R(1), which can be selected to achieve a desired channel depth and width. The radius R(1) can influence the absorption of energy.

[0043] FIG. 7 illustrates cross-section B-B from FIG. 3. As illustrated in FIG. 7, pyramid shaped sections 72 are connected to the outer periphery wall portion 17 by a recurve shaped section 76. FIG. 7 further illustrates sidewalls 18 tapered according to a taper angle 78. Taper angle 78 is preferably 4-6 degrees, though other angles may be used.

[0044] Referring briefly to FIG. 8, product cushioning devices 10 support and protect shock sensitive product 90 in an outer packaging container 92 (e.g., a shipping box). In the illustrated example, product cushioning devices 10 are formed as end caps that abut the inner surfaces of outer packaging container 92. Product cushioning devices 10 wrap around and support product 90 on three sides. The size and shape of the product cushioning devices 10 may vary depending on the application and

the dimensions of the corresponding outer packaging container and the shock sensitive device to be packaged.

[0045] Embodiments may incorporate a variety of features such as, but not limited to, additional ribs, "half pipe" or gully sections to allow the corners to flex more during a drop event, additional curves, flanges, or other features. FIG. 9, for example, illustrates an embodiment of a product cushioning device 100 having end tapered cushions 102 and intermediate tapered cushions 104. Product cushioning device 100 is similar to product cushioning device 10 but includes an additional perimeter flange 106 at the base of the end tapered cushions 102, which adds additional strength for edge drop events. Further, product cushioning device 100 includes multiple intermediate tapered cushions 104.

[0046] FIG. 10, for example, illustrates an embodiment of a product cushioning device 200 having end tapered cushions 202 and intermediate tapered cushion 204. Product cushioning device 200 is similar to product cushioning device 200 but includes additional ribs 206 at end tapered cushions 202 to add additional strength for side drop events.

[0047] While embodiments discussed above are primarily discussed in terms of conical tapered cushions, other embodiments can have other curved geometries. Moreover, in some embodiments, the curvature of the outer walls does not have to match the curvature of the inner walls. For example, in some embodiments, an outer wall may flare out or in compared to a respective inner wall.

[0048] In some embodiments, the cushions have trapezoidal shapes. For example, a cushion inner wall may be defined by a corresponding trapezoid that has at least two sides that converge toward the first axis. In addition, or in the alternative, a cushion outer wall may be defined by a corresponding trapezoid that has at least two sides that converge toward a second axis (with the first axis and the second axis being the same axis in some embodiments).

[0049] It will be understood that while specific embodiments have been presented herein, these embodiments are merely illustrative, and not restrictive. Rather, the description is intended to describe illustrative embodiments, features, and functions in order to provide an understanding of the embodiments without limiting the disclosure to any particularly described embodiment, feature, or function, including any such embodiment, feature, or function described. While specific embodiments of, and examples for, the embodiments are described herein for illustrative purposes only, various equivalent modifications are possible within the spirit and scope of the disclosure, as those skilled in the relevant art will recognize and appreciate.

[0050] As indicated, these modifications may be made in light of the foregoing description of illustrated embodiments and are to be included within the spirit and scope of the disclosure. Thus, while particular embodiments are described, a latitude of modification, various changes and substitutions are intended in the foregoing disclosures, and it will be appreciated that in some instances some features of embodiments of the disclosure will be employed without a corresponding use of other features, and features described with respect to one embodiment may be combined with features of other embodiments without departing from the scope and spirit of the disclosure as set forth.

[0051] The disclosure in the application also includes the following numbered clauses:

1. A product cushioning device for protecting a shock sensitive product, said product cushioning device comprising:

    a wall structure that defines a product receiving area, the product receiving area extending from a product receiving area opening to a product receiving area base, the wall structure comprising a plurality of product contact portions;
    a tapered cushion disposed about a portion of the product receiving area to absorb impact in tri-axial vector directions, the tapered cushion having a plurality of shock value zones and comprising:

        a tapered inner wall that is proximate to the product receiving area and extending from a first inner wall end proximate to the product receiving area base to a second inner wall end distal from the product receiving area base;
        a cushion outer wall that is curved and tapered; and
        a compressible channel structure connecting between the tapered inner wall and the cushion outer wall.

2. The product cushioning device of Clause 1, wherein the product cushioning device is formed of a single sheet of thermoform material.

3. The product cushioning device of Clause 1 or Clause 2, wherein the compressible channel structure has a recurve shape.

4. The product cushioning device of Clause 3, wherein the compressible channel structure comprises a channel inner wall connected to the second inner wall end by a first curved ridge, a curved channel base, a second curved ridge connecting the curved channel base to the cushion outer wall.

5. The product cushioning device of Clause 3 or Clause 4, wherein the wall structure comprises a curved portion that spans between adjacent product contact portions from the plurality of product contact portions, wherein the tapered inner wall of the ta-

pered cushion comprises the curved portion.

6. The product cushioning device of Clause 5, wherein the cushion outer wall spans between the adjacent product contact portions.

7. The product cushioning device of Clause 5 or Clause 6, wherein the tapered inner wall is defined by a first cone and the cushion outer wall is defined by a second cone.

8. The product cushioning device of Clause 7, wherein the first cone and the second cone have apexes on a common axis and wherein the first cone and the second cone taper in opposite directions relative to the common axis.

9. A product cushioning device for protecting a shock sensitive product, comprising:

a wall structure that defines a product receiving area that extends from a product receiving area opening to a product receiving area base, the wall structure comprising a plurality of product contact portions; and
a series of inverted tapered cushions that are adjacent to the product receiving area to absorb impact in tri-axial vector directions, wherein each inverted tapered cushion in the series of inverted tapered cushions has a plurality of shock value zones and comprises:
a tapered inner wall that is proximate to the product receiving area and extending from a first inner wall end proximate to the product receiving area base to a second inner wall end distal from the product receiving area base;
a cushion outer wall that is curved and tapered; and
a compressible channel structure connecting between the tapered inner wall and the cushion outer wall.

10. The product cushioning device of Clause 9, wherein the compressible channel structure of each inverted tapered cushion in the series of inverted tapered cushions has a recurve shape.

11. The product cushioning device of Clause 10, wherein the series of inverted tapered cushions comprises:

an end tapered cushion; and
an intermediate tapered cushion.

12. The product cushioning device of Clause 11, wherein the wall structure defines a stress concentrator between the end tapered cushion and the intermediate tapered cushion.

13. The product cushioning device of Clause 12, wherein the wall structure comprises a curved portion that spans between adjacent product contact portions from the plurality of product contact portions, wherein the tapered inner wall of the intermediate tapered cushion comprises the curved portion.

14. The product cushioning device of Clause 13, wherein the cushion outer wall of the intermediate tapered cushion spans between the adjacent product contact portions.

15. The product cushioning device of Clause 14, wherein the curved portion is defined by a first cone and the cushion outer wall of the intermediate tapered cushion is defined by a second cone.

16. The product cushioning device of Clause 15, wherein the first cone and the second cone have apexes on a common axis and wherein the first cone and the second cone taper in opposite directions relative to the common axis.

17. The product cushioning device of Clause 16, wherein the tapered inner wall of the end tapered cushion comprises a straight wall section.

18. The product cushioning device of any of Clauses 9 to 17, wherein the product cushioning device is formed of a single sheet of thermoform material.

19. The product cushioning device of any of Clauses 9 to 18, wherein the product cushioning device is formed as an end cap.

20. A method for shock protection;

providing a plurality of product cushioning devices, each product cushioning device comprising:

a wall structure that defines a product receiving area, the product receiving area extending from a product receiving area opening to a product receiving area base, the wall structure comprising a plurality of product contact sections;
a tapered cushion disposed about a portion of the product receiving area to absorb impact in tri-axial vector directions, the tapered cushion having a plurality of shock value zones and comprising:

a tapered inner wall that is proximate to the product receiving area and extending from a first inner wall end proximate to the product receiving area base to a

second inner wall end distal from the product receiving area base;
a cushion outer wall that is curved and tapered; and
a compressible channel structure connecting between the tapered inner wall and the cushion outer wall;

inserting a first end of a shock sensitive product into the product receiving area of a first product cushioning device from the plurality of product cushioning devices;
inserting a second end of the shock sensitive product into the product receiving area of a second product cushioning device from the plurality of product cushioning devices; and
placing the shock sensitive product, the first product cushioning device, and the second product cushioning device in a shipping container with the first product cushioning device and the second product cushioning device abutting an inner surface of the shipping container and supporting the shock sensitive product away from the inner surface of the shipping container.

Claims

1. A product cushioning device for protecting a shock sensitive product, said product cushioning device comprising:

a wall structure that defines a product receiving area, the product receiving area extending from a product receiving area opening to a product receiving area base, the wall structure comprising a plurality of product contact portions;
a first tapered cushion disposed about a portion of the product receiving area to absorb impact in tri-axial vector directions, the first tapered cushion having a plurality of shock value zones and comprising:

a tapered inner wall that is proximate to the product receiving area and extending from a first inner wall end proximate to the product receiving area base to a second inner wall end distal from the product receiving area base;
a cushion outer wall that is curved and tapered; and
a compressible channel structure connecting between the tapered inner wall and the cushion outer wall.

2. The product cushioning device of Claim 1, wherein the product cushioning device is formed of a single sheet of thermoform material.

3. The product cushioning device of Claim 1 or Claim 2, wherein the compressible channel structure has a recurve shape.

4. The product cushioning device of Claim 3, wherein the compressible channel structure comprises a channel inner wall connected to the second inner wall end by a first curved ridge, a curved channel base, a second curved ridge connecting the curved channel base to the cushion outer wall.

5. The product cushioning device of Claim 3 or Claim 4, wherein the wall structure comprises a curved portion that spans between adjacent product contact portions from the plurality of product contact portions, wherein the tapered inner wall of the first tapered cushion comprises the curved portion.

6. The product cushioning device of Claim 5, wherein the cushion outer wall spans between the adjacent product contact portions.

7. The product cushioning device of Claim 5 or Claim 6, wherein the tapered inner wall is defined by a first cone and the cushion outer wall is defined by a second cone.

8. The product cushioning device of Claim 7, wherein the first cone and the second cone have apexes on a common axis and wherein the first cone and the second cone taper in opposite directions relative to the common axis.

9. The product cushioning device of any of Claims 1 to 8, further comprising:
a series of inverted tapered cushions that are adjacent to the product receiving area to absorb impact in tri-axial vector directions, wherein each inverted tapered cushion in the series of inverted tapered cushions has a respective plurality of shock value zones and comprises:

a respective tapered inner wall that is proximate to the product receiving area and extending from a respective first inner wall end proximate to the product receiving area base to a respective second inner wall end distal from the product receiving area base;
a respective cushion outer wall that is curved and tapered; and
a respective compressible channel structure connecting between the tapered inner wall and the cushion outer wall, wherein the first tapered cushion is one in the series of inverted tapered cushions.

10. The product cushioning device of Claim 9, wherein the respective compressible channel structure of

each inverted tapered cushion in the series of inverted tapered cushions has a respective recurve shape.

11. The product cushioning device of Claim 10, wherein the series of inverted tapered cushions comprises:

an end tapered cushion; and
an intermediate tapered cushion.

12. The product cushioning device of Claim 11, wherein the wall structure defines a stress concentrator between the end tapered cushion and the intermediate tapered cushion.

13. The product cushioning device of Claim 11, wherein the respective tapered inner wall of the end tapered cushion comprises a straight wall section.

14. The product cushioning device of any of Claims 9 to 13, wherein the product cushioning device is formed as an end cap.

15. A method for shock protection;

providing a plurality of product cushioning devices, each product cushioning device comprising:

a wall structure that defines a product receiving area, the product receiving area extending from a product receiving area opening to a product receiving area base, the wall structure comprising a plurality of product contact sections;
a tapered cushion disposed about a portion of the product receiving area to absorb impact in tri-axial vector directions, the tapered cushion having a plurality of shock value zones and comprising:

a tapered inner wall that is proximate to the product receiving area and extending from a first inner wall end proximate to the product receiving area base to a second inner wall end distal from the product receiving area base;
a cushion outer wall that is curved and tapered; and
a compressible channel structure connecting between the tapered inner wall and the cushion outer wall;

inserting a first end of a shock sensitive product into the product receiving area of a first product cushioning device from the plurality of product cushioning devices;
inserting a second end of the shock sensitive product into the product receiving area of a second product cushioning device from the plurality of product cushioning devices; and
placing the shock sensitive product, the first product cushioning device, and the second product cushioning device in a shipping container with the first product cushioning device and the second product cushioning device abutting an inner surface of the shipping container and supporting the shock sensitive product away from the inner surface of the shipping container.

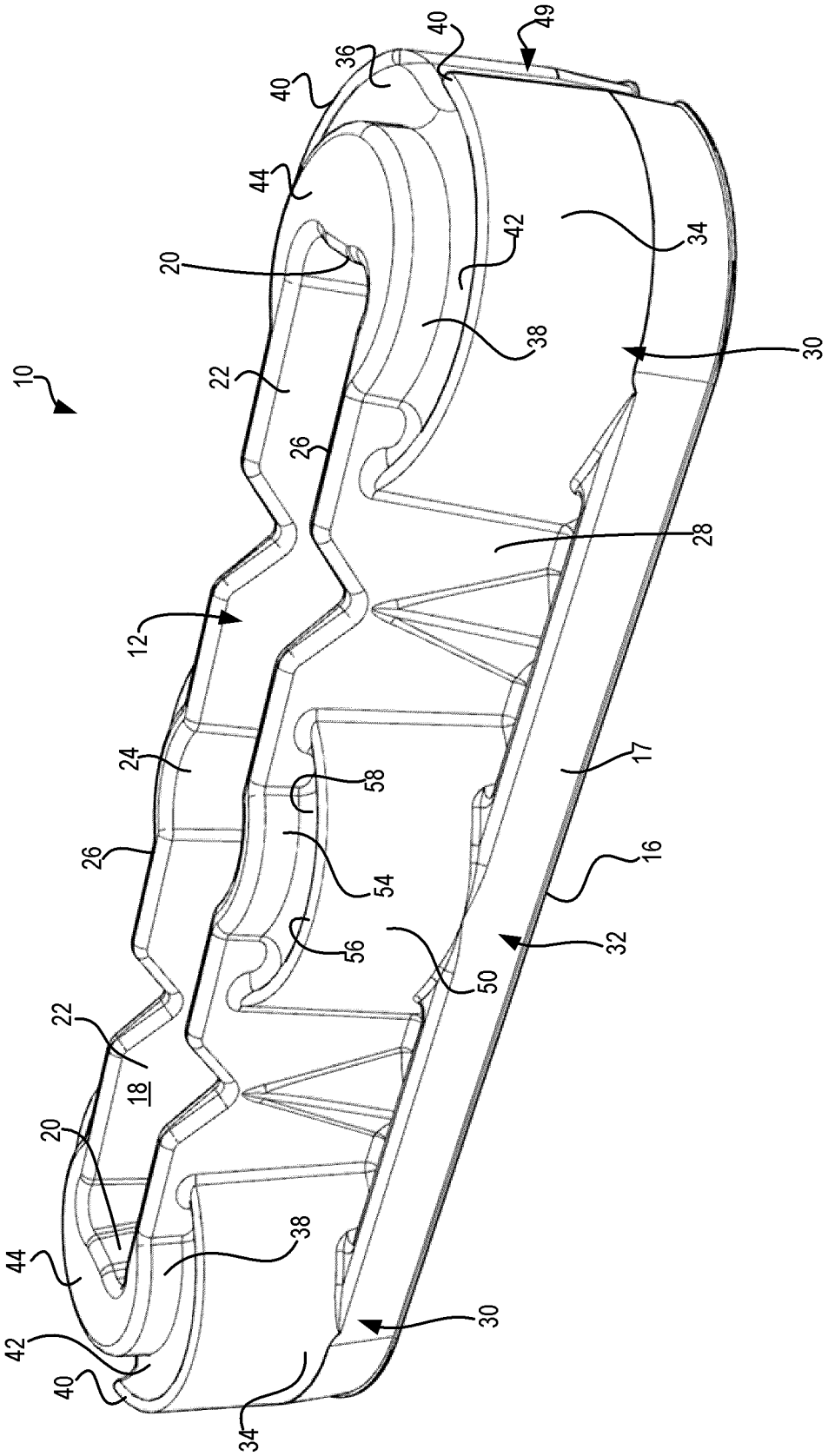

FIG. 1

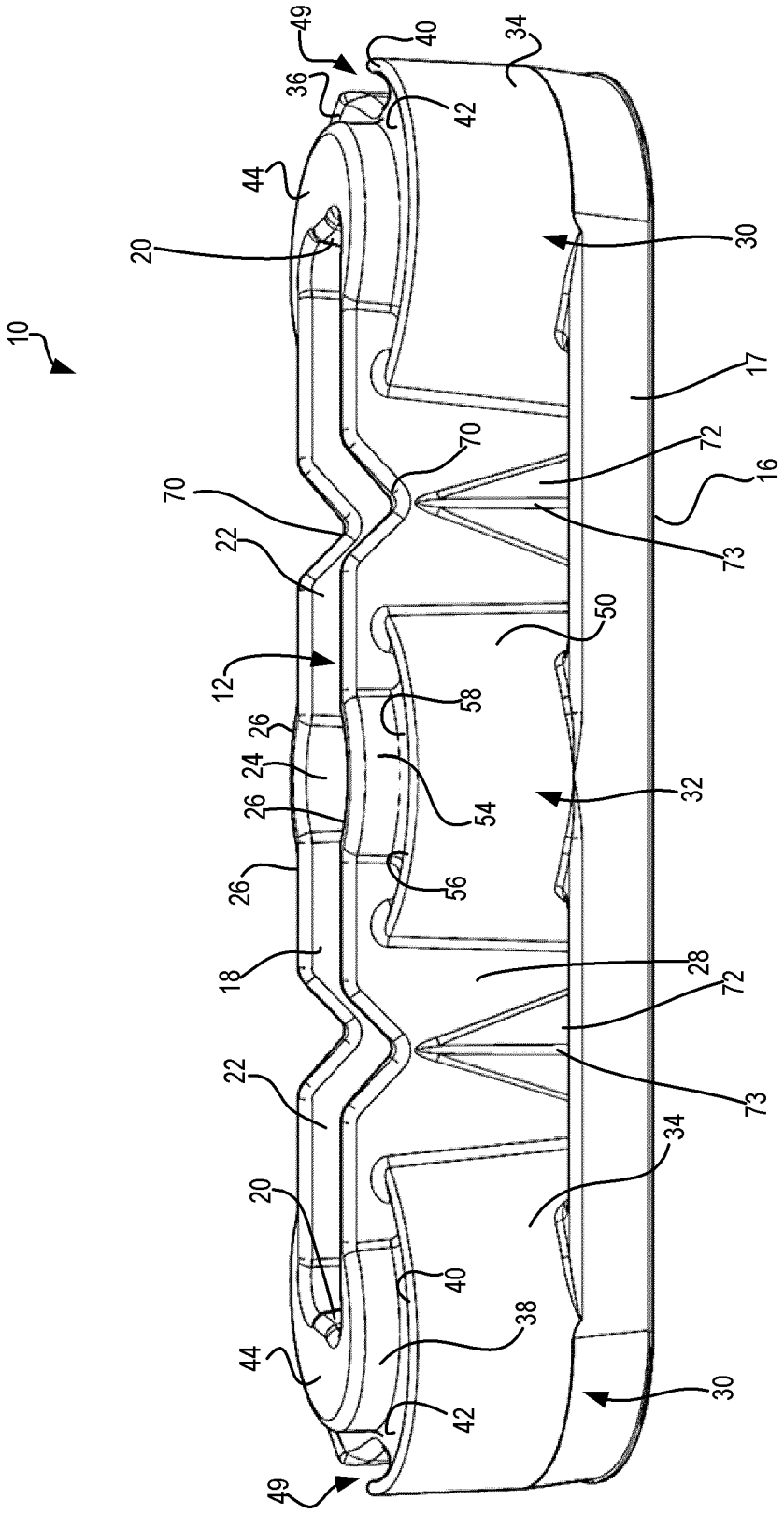
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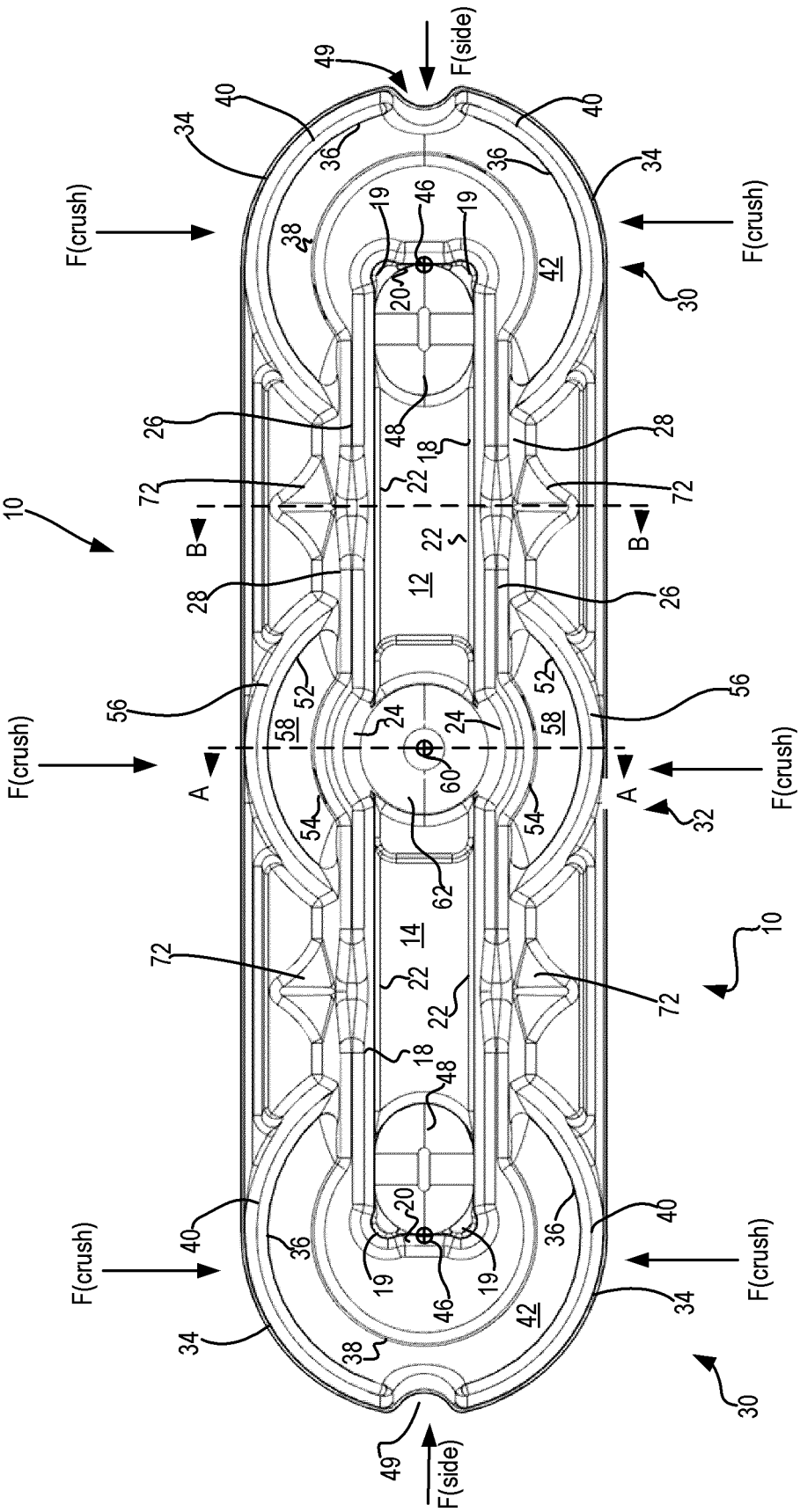
FIG. 2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36
F(crush)
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22
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B
12
A
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56
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62
14
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FIG. 3

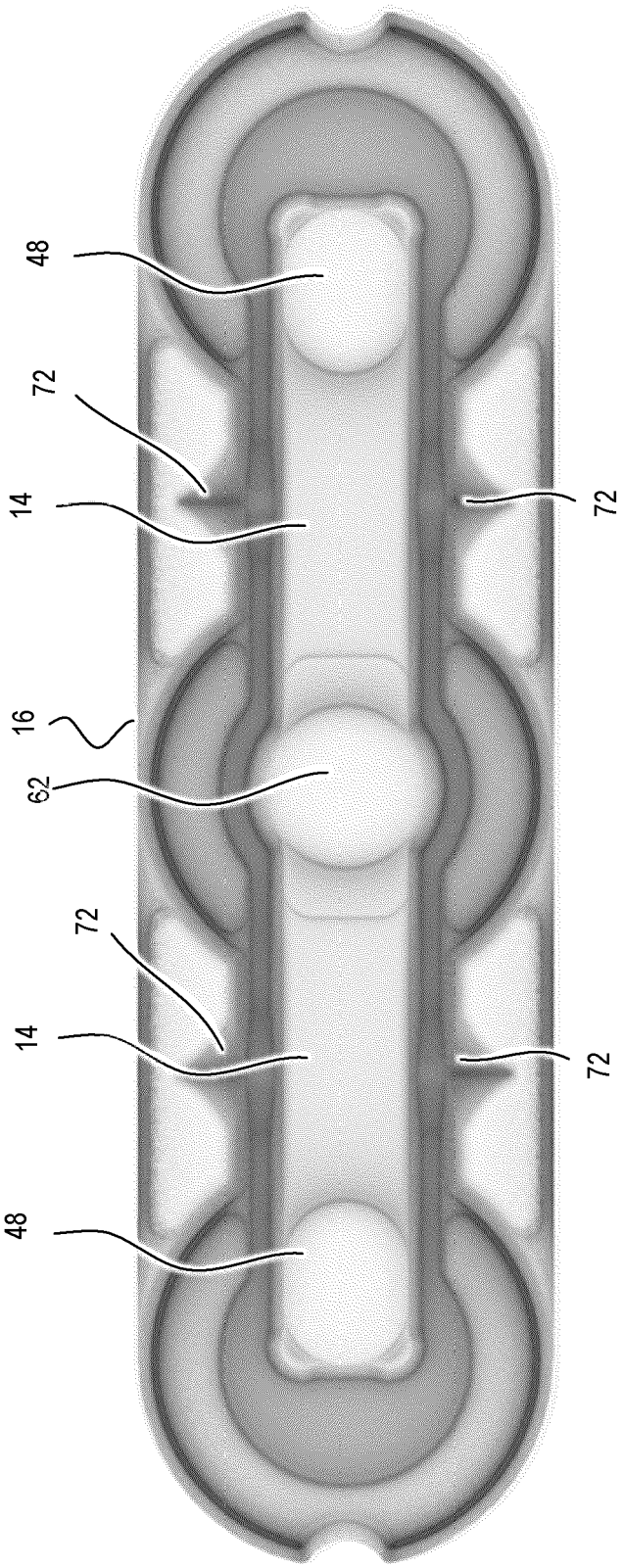
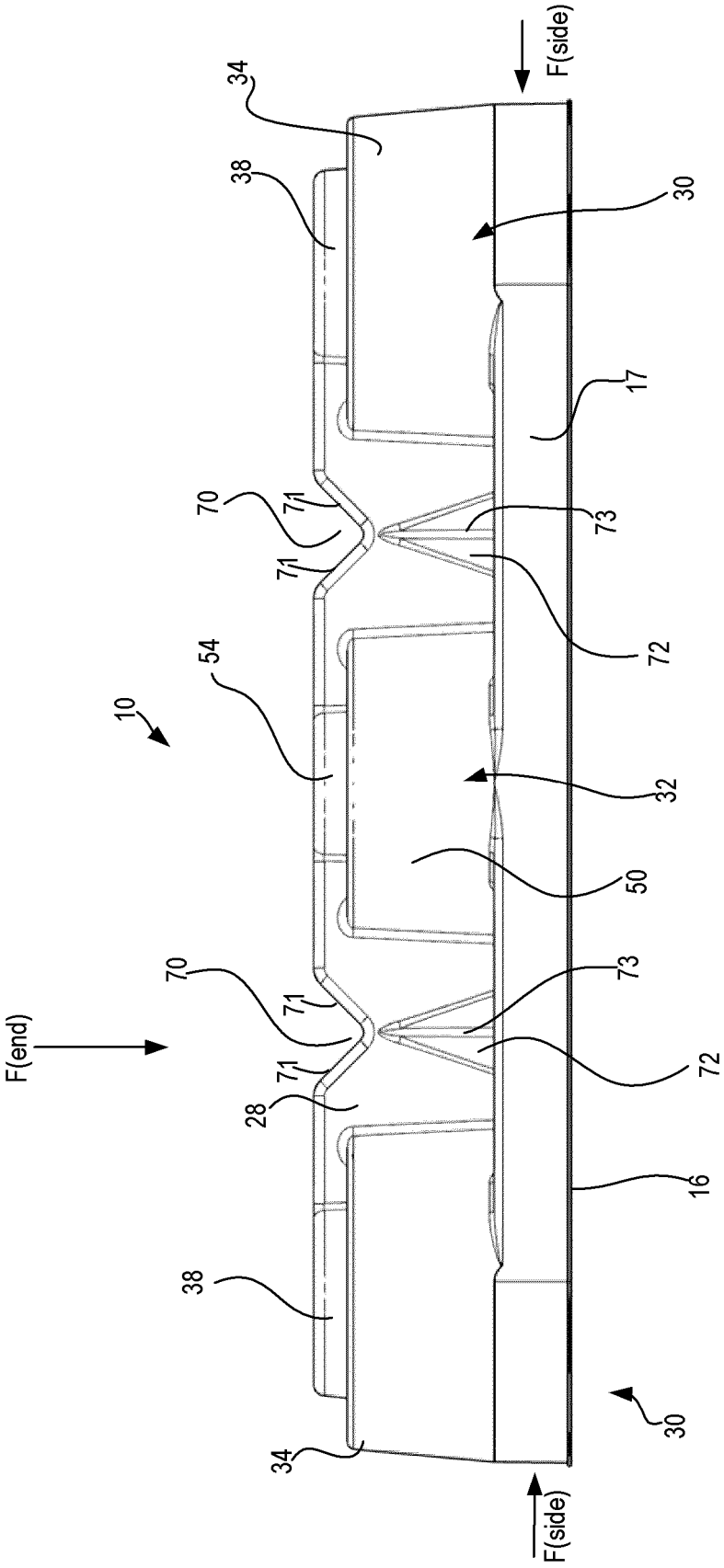


FIG. 4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F(side)

FIG. 5

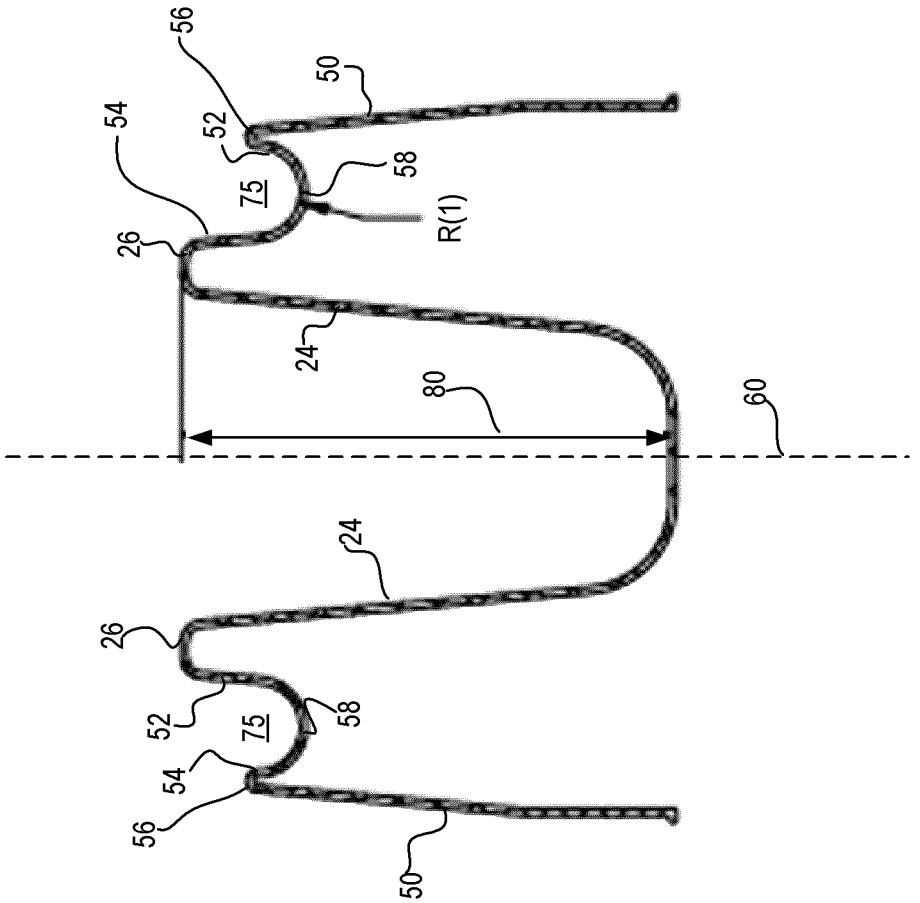

FIG. 6

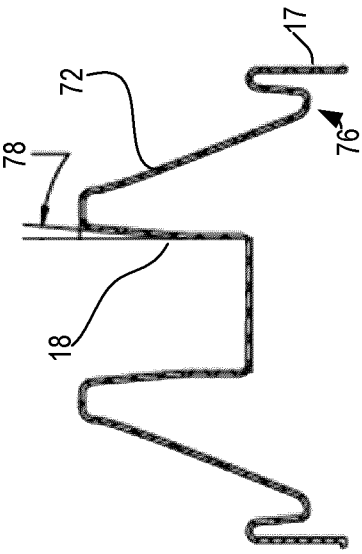

FIG. 7

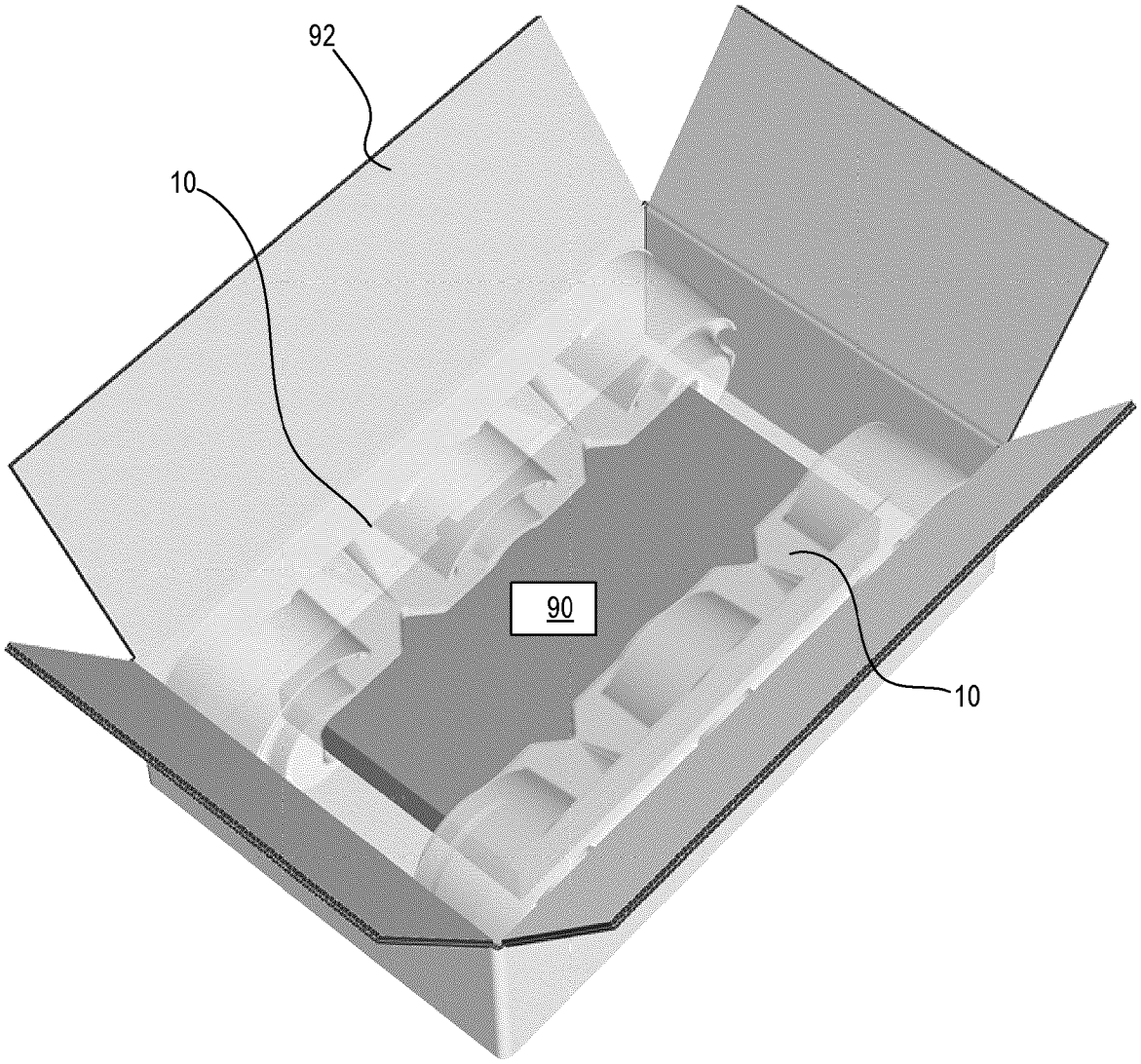

FIG. 8

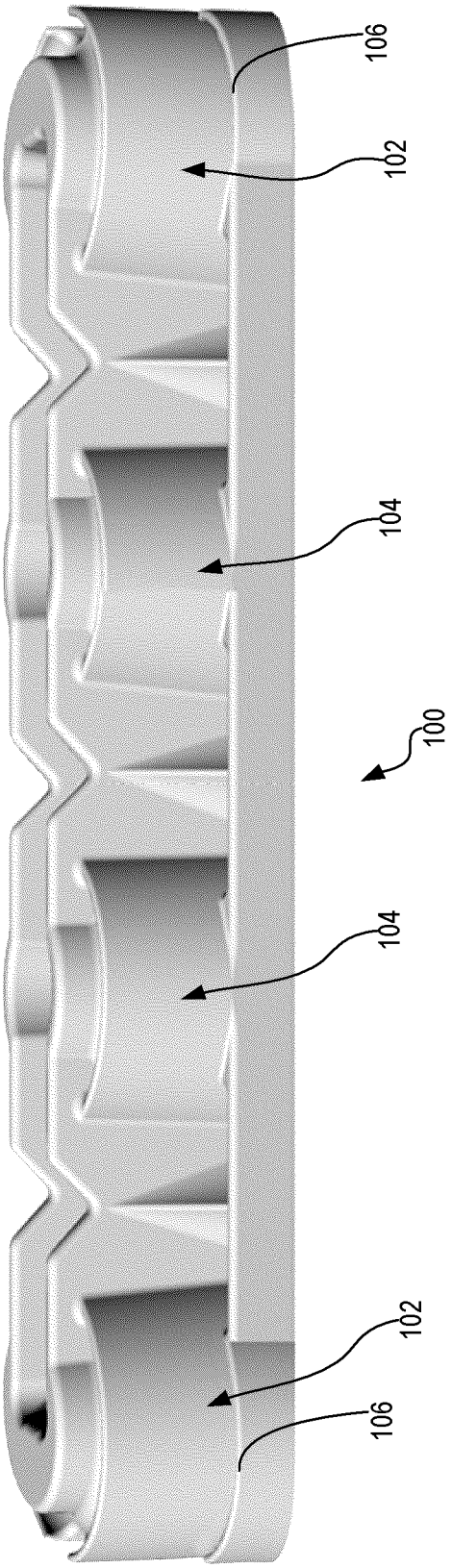

FIG. 9

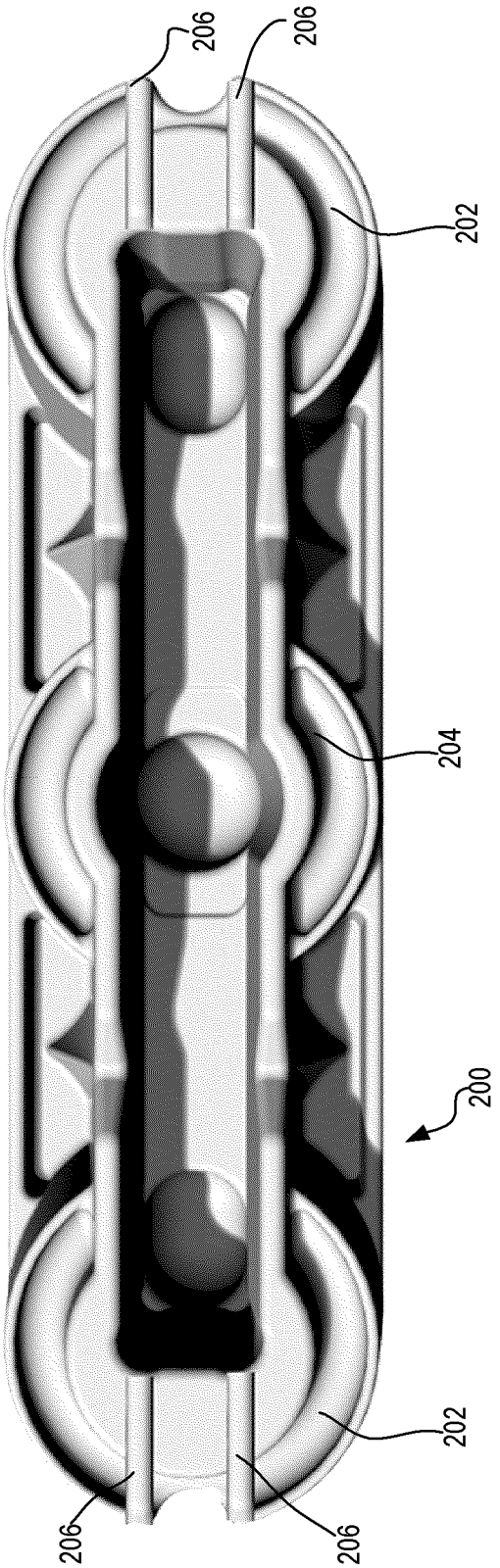

FIG. 10

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EUROPEAN SEARCH REPORT

Application Number
EP 24 20 7487

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2002/023857 A1 (SMITH FORREST [CA]) 28 February 2002 (2002-02-28) * figures 1-14 *	1-15	INV. B65D81/113
X	US 2004/055928 A1 (SMITH FORREST [US]) 25 March 2004 (2004-03-25) * figure 1 *	1-15	

TECHNICAL FIELDS SEARCHED (IPC)

B65D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	10 March 2025	Sacepe, Nicolas

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10-03-2025

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