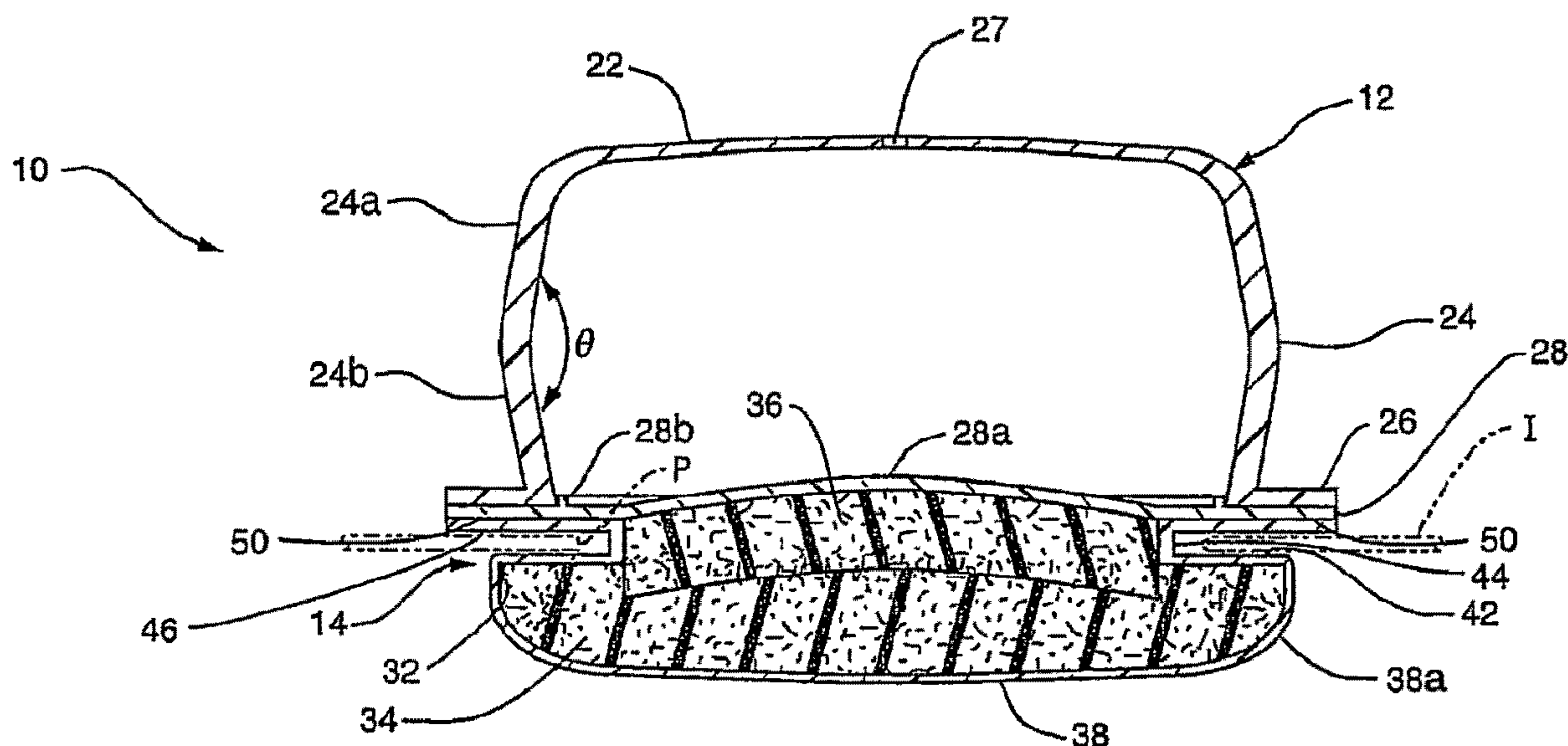




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(57) Abrégé/Abstract:

A protective headgear compression member (10) includes a hollow compression cell (12) having a top wall (22), a bowed side wall (24) and a bottom wall (26,28) and a liner element (14) secured to that bottom wall coaxially to said cell. The liner element is composed of a flexible envelope (32) substantially-filled with resilient material (34,36) and the envelope is secured to the bottom wall via an axially flexible connection to prevent the bottoming out of the liner element against the bottom wall of the cell.

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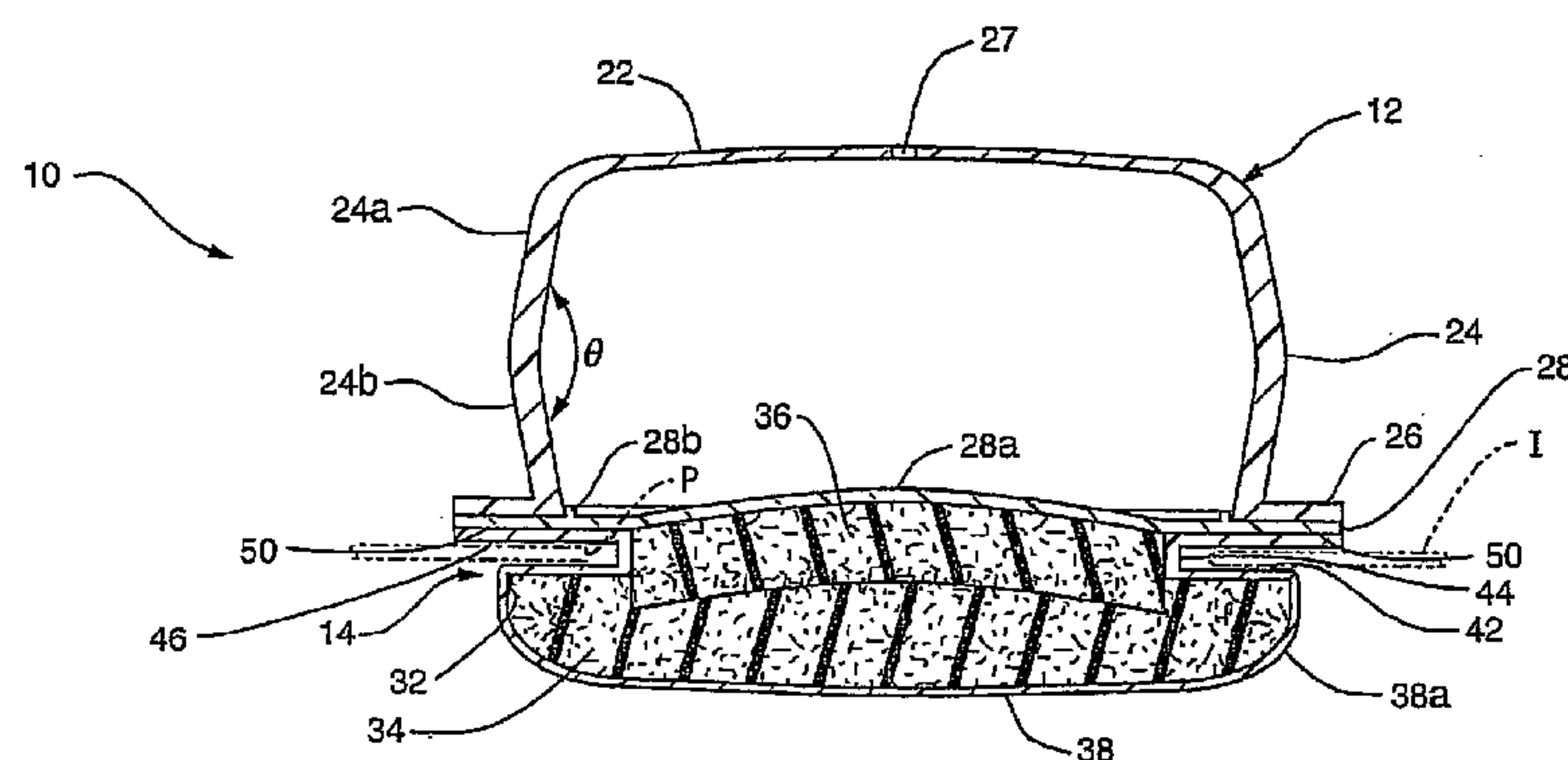


FIG. 4

(57) Abstract: A protective headgear compression member (10) includes a hollow compression cell (12) having a top wall (22), a bowed side wall (24) and a bottom wall (26, 28) and a liner element (14) secured to that bottom wall coaxially to said cell. The liner element is composed of a flexible envelope (32) substantially-filled with resilient material (34, 36) and the envelope is secured to the bottom wall via an axially flexible connection to prevent the bottoming out of the liner element against the bottom wall of the cell.

PROTECTIVE HEADGEAR COMPRESSION MEMBER

BACKGROUND OF THE INVENTION

5 *Field of the Invention*

This invention relates to protective headgear and other impact absorbing structures. It relates especially to an impact absorbing compression member for use therein.

Background Information

10 Headgear such as a helmet is often worn by individuals during games and other physical activities to help protect the wearers from head injury. Head injury can result from impact forces due to contact with other people or objects. Currently marketed helmets generally fall into one of two categories, i.e. single impact helmets or multiple impact helmets. Single impact helmets undergo permanent deformation under impact, whereas multiple impact helmets are capable of
15 withstanding multiple blows. The wearers of single impact helmets include, for example, bicyclists and motorcyclists. On the other hand, participants in sports such as hockey and football and construction workers generally wear multiple impact helmets. Both categories of helmets have similar constructions which include a semi-rigid outer shell which distributes the force of an impact over a wide area, a crushable layer inside the shell which reduces the force of the
20 impact on the wearer's head, and usually also an inner liner that helps to shape the helmet to the wearer's head. Invariably, such helmets also include a chin strap for securing the helmet to the wearer's head.

Recently, there has been developed a class of protective headgear incorporating a plurality of energy-absorbing layers. Such headgear is disclosed, for example, in publications
25 WO2006/089234 and WO2006/089235 and US2007/0190292, published August 16, 2007. As seen there, such helmets include a semi-rigid outer layer or shell, an inner layer and a middle layer between the outer and inner layers. This middle layer is composed of a plurality of individual compressible cells disposed in a fluid-containing interstitial region formed by the inner and outer layers. At least one passageway is provided by which fluid can leave the middle
30 layer as the outer layer deforms in response to an impact on the helmet. Such helmets may also

contain a dynamic inner liner whose shape can change to conform to a wearer's head as each helmet is drawn down on the head by the associated chin strap; see WO2006/089098.

As seen from the aforesaid publications, each impact absorbing cell of the middle layer of the helmet comprises at least one thin-walled enclosure having an uncompressed configuration
 5 which defines a hollow chamber, a volume of fluid at least partially filling that chamber, at least one orifice through the enclosure wall that resistably vents fluid from the chamber in response to an impact on the enclosure and an impact-absorbing mechanism associated with the enclosure that resists yielding in response to an initial phase of an impact on the enclosure, and that yields to the impact after the initial phase of the impact to allow the remainder of the impact to be
 10 managed by the fluid venting from the orifice. In a preferred protective helmet, the dynamic inner liner is composed of individual compressible elements positioned at the cell locations and whose shapes can change to conform to a wearer's head as the helmet is drawn down on the head by an associated chin strap assembly. Thus, each cell and the corresponding compressible element form a unitary compression member.

15 While the aforesaid protective helmets and structures employing such impact-absorbing compression members perform their impact-absorbing function quite well, the total thickness of the helmet layers is larger than might be desired. Also, the compressible structures forming the dynamic inner liner of the helmet are usually simply foam pads or capsules adhered to the underside of the associated cell and are prone to bottoming out when the helmet is pressed
 20 against the wearer's head by high impact forces, thus causing discomfort to the wearer. Simply increasing the thickness of the pads in an attempt to overcome this problem results in an undesirable increase in helmet size.

SUMMARY

25 Accordingly, it is desirable to provide a compression member in the nature of a shock absorber for providing the middle layer and liner of a helmet or other protective structure.

It is further desirable to provide such a compression member which has minimal overall thickness, yet whose components do not tend to bottom out under the compression forces encountered during normal use of the member.

30 It is further desirable to provide a compression member of this type which is relatively easy to releasably attach to the inner layer of a helmet or other protective structure.

It is further desirable to provide such a compression member which when incorporated into a helmet along with a multiplicity of other similar members produces headgear which is comfortable to wear for a prolonged period even when the helmet is repeatedly impacted from without.

5 It is further desirable to provide such a compressible member composed of a few molded plastic parts which are relatively easy to assemble.

In an aspect, there is provided a compression member for a protective structure, the member comprising: a hollow, axially symmetric compression cell having a top wall, a bowed side wall and a bottom flange extending laterally out from the side wall, and a plate that is co-
 10 extensive with the flange position and against the underside of the flange, the flange and plate secured together at their peripheries; a liner element secured coaxially to the cell, the liner element including an axially flexible envelope with a bottom wall extending up to an outer edge of an annular shoulder that has an inner edge connected to a laterally extending second flange that is coextensive with the plate, the second flange being positioned against the underside of the
 15 plate and the second flange and plate being secured together at their peripheries, and a resilient material substantially filling the envelope.

Other features will, in part, be obvious and will, in part, appear hereinafter. The invention accordingly comprises the features of construction, combination of elements and arrangement of parts which will be exemplified in the following detailed description, and the scope of the
 20 invention will be indicated in the claims.

In general, an example protective helmet compression member includes a hollow, axially symmetric compression cell having an upper wall, a side wall and a flanged bottom wall. The compression member also includes a compressible liner element mounted to the flange. This element is composed of a hollow flexible envelope having a bottom wall and a side wall
 25 extending upwardly/inwardly from that bottom wall and connected to a radial flange that is secured flush to the cell flange. The envelope is substantially filled by one or more resilient pads.

Preferably, the bottom wall of the cell inboard the cell flange is curved upwardly, giving the cell a dished or concave undersurface to provide additional clearance for the pad(s). This construction along with the pad(s) enables the compression member to withstand appreciable
 30 compression forces without the liner element bottoming out against the underside of the cell. Resultantly, when a multiplicity of the compression members are

incorporated into a protective structure such as a football helmet, the structure is comfortable to wear for a prolonged period, despite repeated impacts thereto.

BRIEF DESCRIPTION OF THE DRAWINGS

For a further understanding of the nature and objects of the invention, reference
5 should be made to the following detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is a side elevational view of a protective helmet incorporating compression members in accordance with this invention;

FIG. 2 is a perspective view, on a larger scale, showing one of the compression
10 members of the FIG. 1 helmet in greater detail;

FIG. 3 is an exploded perspective view showing the components of the FIG. 2 compression member in greater detail, and

FIG. 4 is a sectional view taken along line 3-3 of FIG. 2.

DESCRIPTION OF A PREFERRED EMBODIMENT

15 Referring to FIG. 1 of the drawings, compression members incorporating the invention and indicated generally at 10 are shown incorporated into a protective structure, i.e., a football helmet H having an outer layer or shell shown in phantom at O and an inner layer I. Members 10 are releasably secured to layer I. As described in the above publications, shell O is of a relatively hard plastic material that deforms locally and radially
20 in response to an impact, and the inner layer I may be of a softer, less rigid material.

Each compression member 10 comprises a hollow, compressible, resilient cell 12 which extends between the inner and outer layers, and a compressible liner element 14 located directly opposite cell 12 and which projects from the interior surface of layer I. Cells 12 collectively form a helmet middle layer in an interstitial region between layers O
25 and I and elements 14 collectively form a dynamic inner liner of the helmet.

As shown in FIG. 4, each member 10 is secured in a different opening P in inner layer I by capturing the edge of that opening P between the associated cell 12 and its liner element 14. The inner layer I is somewhat elastic so that the member 10 may be attached

to layer I by forcing its cell 12 through opening P, whose edge then snaps into a peripheral recess around the cell as will be described in detail later.

Each cell 12 comprises a top wall 22, a bowed side wall 24 composed of a pair of back-to-back frustoconically shaped segments 24a and 24b and a radial flange 26 extending out from the free lower edge of the segment 24b, leaving a large central opening within the flange. A vent hole 27 is provided in top wall 22. In one working example of member 10 suitable for a football or motorcycle helmet, the top wall 22 has a diameter of 1.9 in., the side wall 24 has a diameter of 2.0 in. at the equator with an included angle θ of 155 to 162 degrees between segments 24a and 24b, and the flange 26 has an outer diameter of 2.3 in. Cell 12 is of a material, e.g. TPU, which is relatively stiff, yet allows the cell as a whole to flex to provide the impact absorbing characteristics described in the above publications.

A plate 28 of the same material about 0.04 in. thick is positioned against the underside of the flange and the two are welded together at their edges to close and complete the bottom of the cell. Preferably a central area 28a of the plate is domed or upwardly curved (about 0.08 in. deflection) to conform to a typical head curvature for reasons to be described later. Also, a circular step or wall 28b may be provided on the upper surface of the plate to center the cell on the plate.

As shown in FIGS. 2 and 3, the liner element 14 is coaxial to cell 12 and has more or less the same footprint as the cell. Instead of being a simple compressible bellows capsule or pad as described in the above publications, each element 14 is a composite structure which includes a cup-like hollow envelope or membrane 32, a first, soft resilient pad 34 and a second, smaller, denser resilient pad 36.

Envelope 32 is of a flexible plastic material such as TPU. It has a circular bottom wall 38 with a gently rounded edge margin 38a which extends up to the radially outer edge of a relatively stiff annular shoulder 42. The inner edge of shoulder 42 connects to a short, e.g. 0.06 in., upstanding neck 44 whose upper end transitions to a radially outer flange 46. The outer diameter of flange 46 is substantially the same as that of flange 26 and plate 28 of cell 12.

In accordance with the invention, the bottom wall 38, 38a of envelope 32, while strong, is also quite thin and flexible, whereas the envelope shoulder, neck and flange have thicker walls so that they are individually relatively stiff. In the above working example, the wall 38, 38a has a thickness of 0.02 inch and the shoulder, neck and flange have wall thicknesses of 0.02, 0.03 and 0.03 inch, respectively. In the above example of member 10, the overall height of the liner element is in the order of 0.33 inch.

As best seen in FIGS. 3 and 4, the pad 34 is die cut of a foam material, e.g. open cell polyurethane foam of density 18 to 15 lb./cu.ft. and its diameter, e.g. 2.05 in., and thickness, e.g. 0.28 in., are such that the pad can fit within the confines of envelope bottom wall 38, 38a.

On the other hand, the smaller pad 36 is die cut of a stiffer plastic foam material, e.g. vinyl nitrile 602 having a density 17 to 25 lb./cu.ft. and its diameter, e.g. 1.4 in., and thickness, e.g. 0.20 in., are such as to enable that pad to fit within the neck 44 of envelope 32 between pad 34 and plate 28. The pads 34 and 36 are die cut in the circular shapes shown in FIG. 3, not FIG. 4. They assume the shapes shown in FIG. 4 when the envelope or membrane 38, 38a is installed around them.

To assemble the liner element 14 to cell 12, the pad 34 is inserted into envelope 32 so that it is flush against bottom wall 38. Then, pad 36 is positioned against the underside of plate portion 28a within neck 44. To hold pad 36 in place during assembly, an adhesive or double sided tape (not shown) may be interposed between pad 36 and the plate portion 28a. Finally, the flange 46 of envelope 32 and the flange 26 of cell 12 are positioned together coaxially and welded or otherwise secured together as shown at 50 in FIG. 4. This leaves the shoulder 42 and neck 44 free to flex in the axial direction.

Preferably, the thickness of pad 36 is such that when the two flanges are secured together at 50, the two pads 34 and 36 substantially fill the space between the plate 28 and bottom wall 38, 38a so that the underside of the liner element 14 constitutes a soft pillow that conforms to the shape of any surface contacting that wall. The fact that the liner element 14 is movable axially relative to cell 12 and the presence of the pads minimize the likelihood of the liner element 14 bottoming out should that element be subjected to high compression forces due to impacts to helmet H (FIG. 1) when the helmet is

on a wearer's head. That the central portion 28a of plate 28, i.e. the area thereof within the cell 12, is upwardly curved or dished as described above also helps in this respect in that it provides additional clearance between the plate and a wearer's head without increasing the overall height of the compression member 10. This height is typically in the order of 2.0 in. for a cell 10 used in a helmet. That height may be as small as 1.0 in. when the cell is used in other applications, e.g. as a jaw shock absorber.

When a player dons the helmet H, the composite liner element 14 of each compression member 10 conforms to the wearer's head resulting in a very comfortable fit of the helmet to the head. Yet, each member 10 still has a relatively low profile within helmet H so that the helmet is no larger than a conventional helmet that does not incorporate the members 10. Finally, because of the aforesaid composite construction of the liner element 14, that element is not likely to bottom out during normal use of the helmet.

It will thus be seen that the features set forth among those made apparent from the preceding description above can be efficiently attained in embodiments disclosed herein. Also, certain changes may be made in the construction described above without departing from the scope of the invention. For example, although the cell 12 of the compression member 10 specifically described has a circular cross section, other cell shapes are possible so long as the edges of the cell form a symmetrical shape that passes through a specific set of points arranged in a specific pattern as described in the above US2007/0190292 and the liner element 14 has more or less the same footprint as the cell flange. Also, instead of forming pads 34, 36 as separate elements, they may be formed as a unit with a varying density or as a collection of resilient particles. Therefore, it is intended that all matter contained in the above description or showing in the accompanying drawings be interpreted as illustrative and not in a limiting sense.

It is also understood that the following claims are intended to cover all of the generic and specific features of the invention described herein.

CLAIMS

- 1 1. A compression member for a protective structure, said member comprising:
2 a hollow, axially symmetric compression cell having a top wall, a bowed side
3 wall and a bottom flange extending laterally out from the side wall, and a plate that is co-
4 extensive with the flange position and against the underside of the flange, said flange and
5 plate secured together at their peripheries;
6 a liner element secured coaxially to said cell, said liner element including an axi-
7 ally flexible envelope with a bottom wall extending up to an outer edge of an annular
8 shoulder that has an inner edge connected to a laterally extending second flange that is
9 coextensive with said plate, said second flange being positioned against the underside of
10 the plate and the second flange and plate being secured together at their peripheries, and
11 a resilient material substantially filling said envelope.
- 1 2. The member defined in claim 1 wherein the resilient material is composed of at
2 least two layers having different densities with the least dense layer being adjacent to said
3 bottom wall.
- 1 3. The member defined in claim 2 wherein said layers are comprised of plastic foam.
- 1 4. The member defined in claim 3 wherein the layers are separate foam pads.
- 1 5. The member defined in claim 1 wherein the plate has an upwardly dished central
2 area inboard said cell flange to provide additional clearance for the resilient material ad-
3 jacent to the plate.
- 1 6. The member defined in claim 1 wherein the inner edge of the annular shoulder is
2 connected to the second flange by way of a neck.

1 7. The member defined in claim 6 wherein said resilient material comprises a rela-
2 tively soft first layer adjacent to and coextensive with the bottom wall and a second,
3 smaller, denser layer within said neck between said first layer and said plate.

1 8. The member defined in claim 7 wherein said plate has an upwardly dished central
2 area inboard the cell flange to provide additional clearance for said second layer.

1 9. The member defined in claim 1 wherein the cell and liner element each have a
2 circular cross-section.

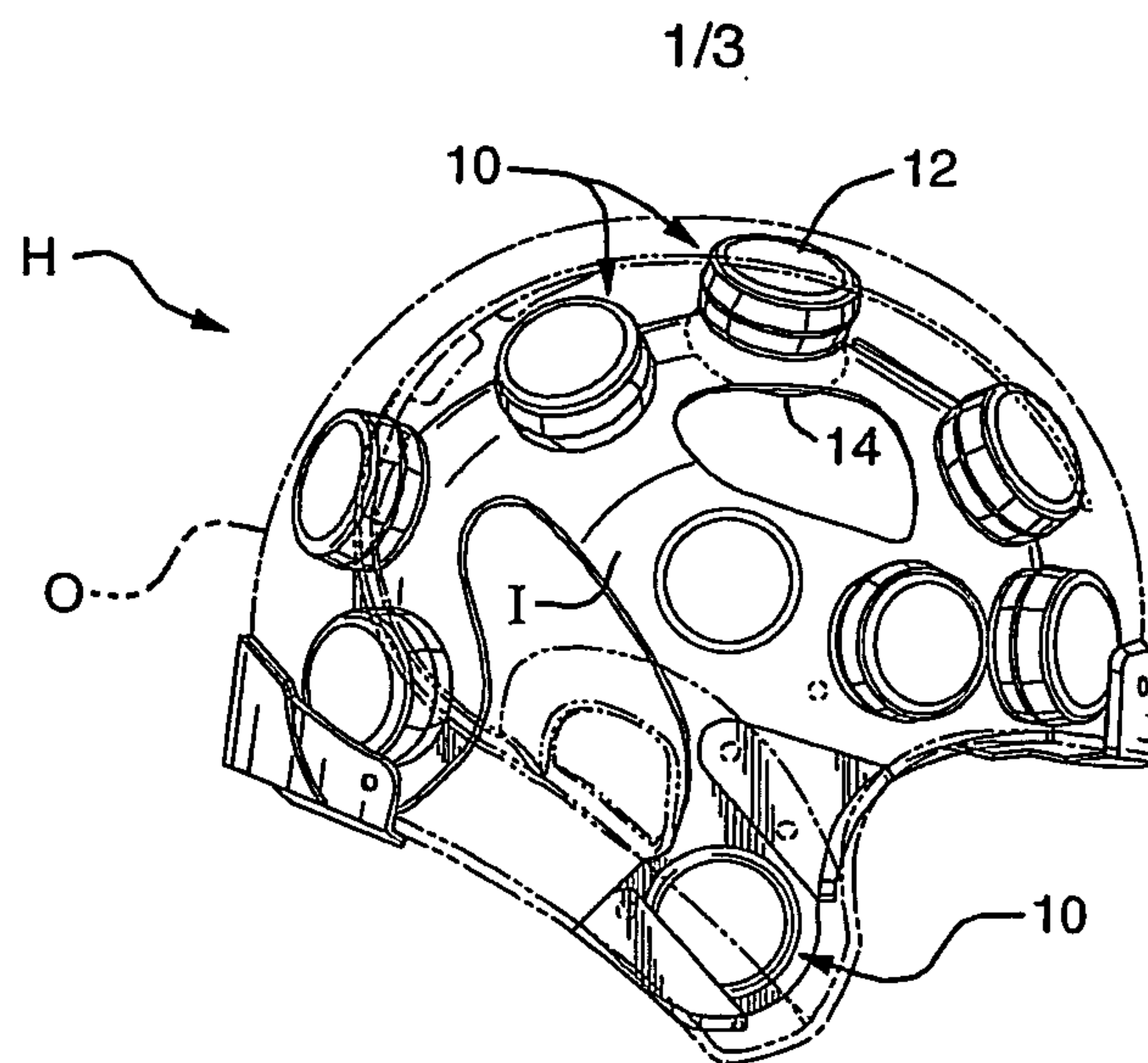


FIG. 1

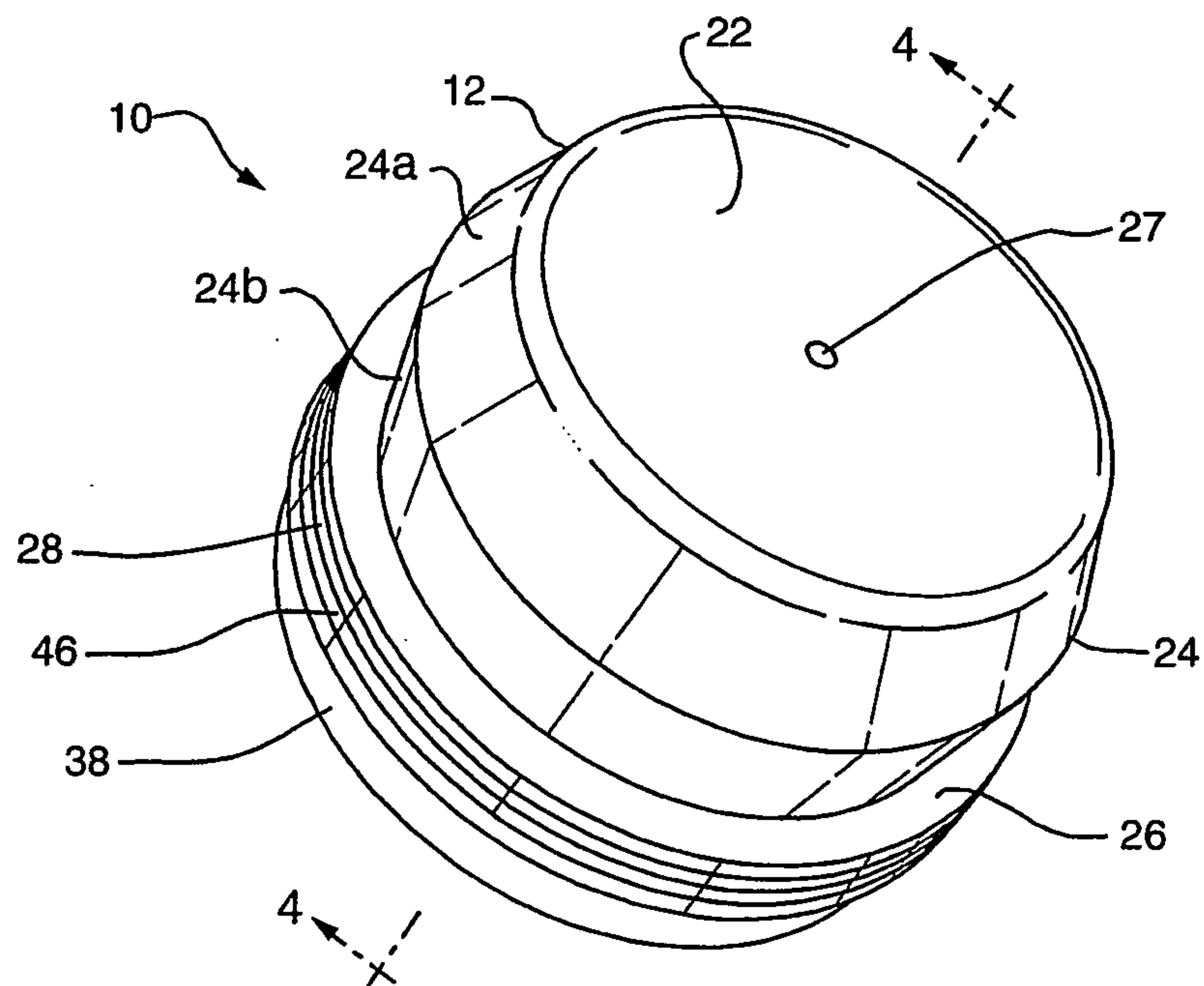
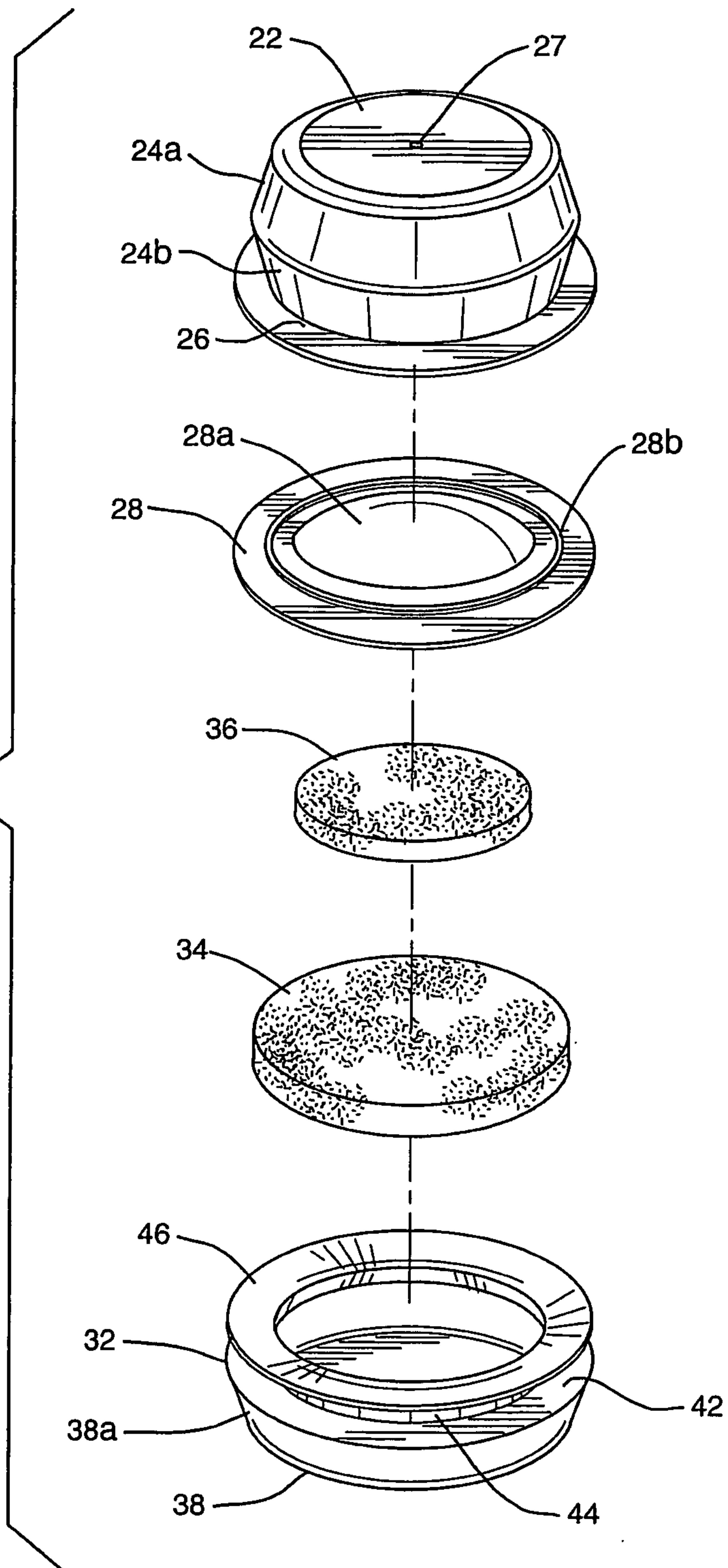


FIG. 2

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FIG. 3



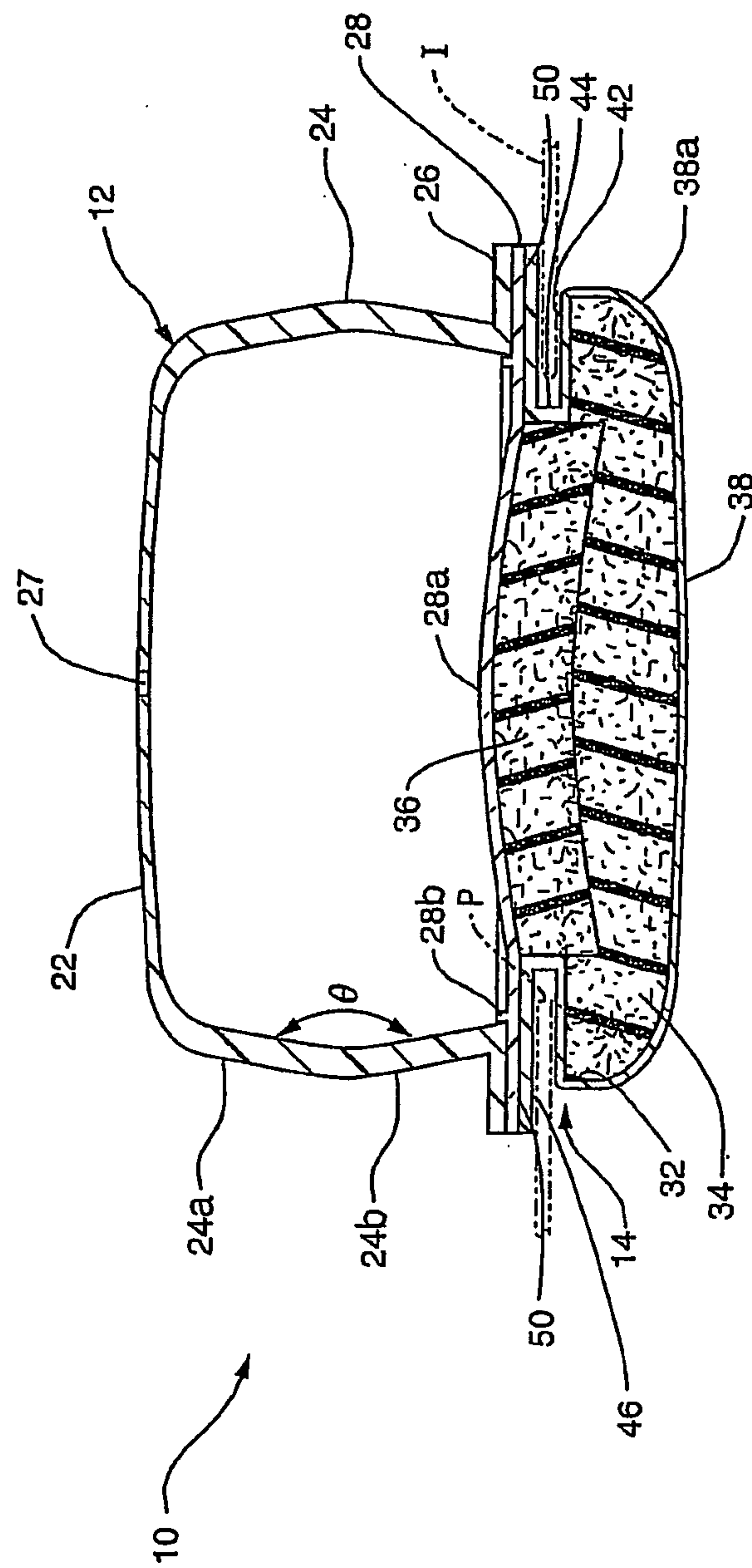


FIG. 4

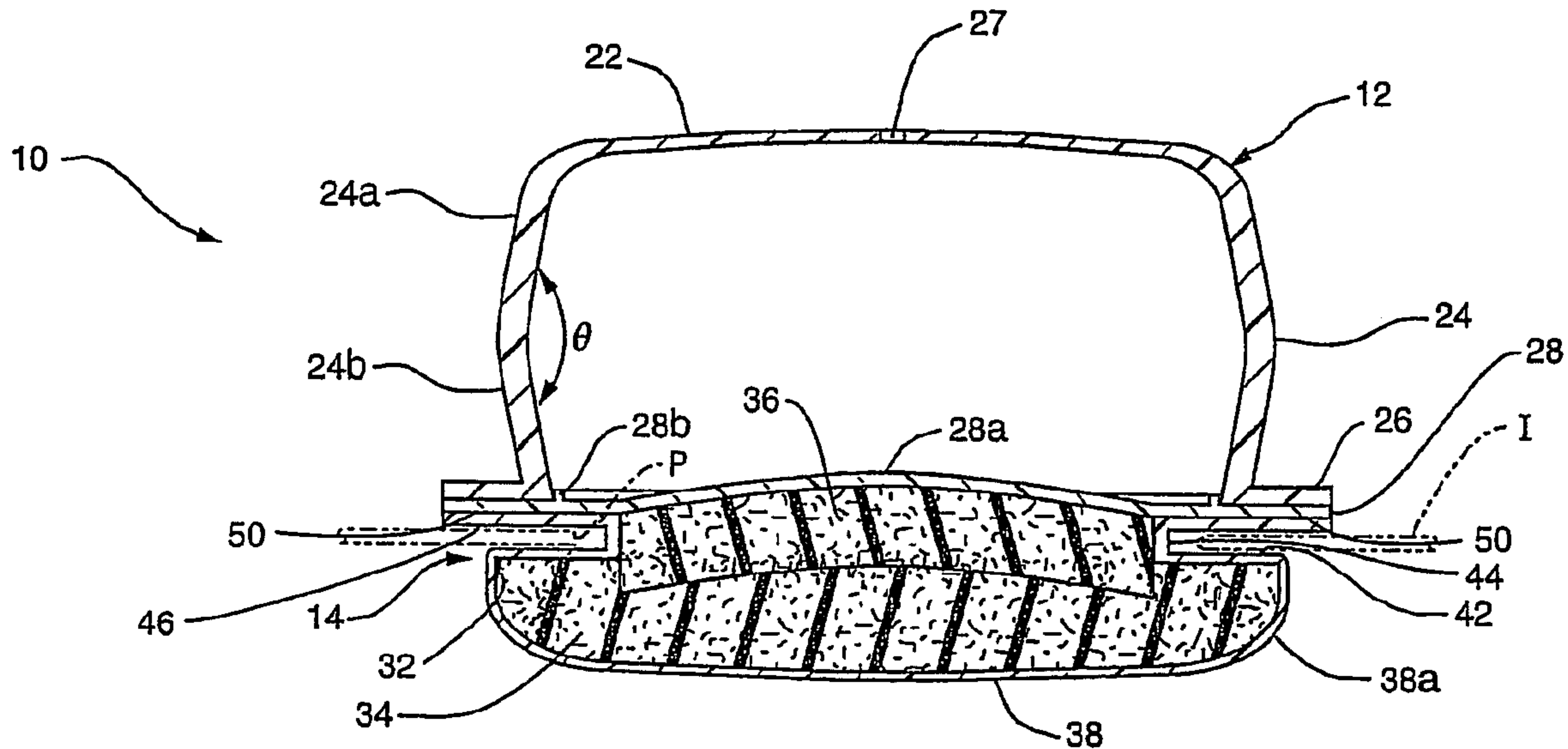


FIG. 4