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(54) **PROTECTIVE HEADGEAR COMPRESSION MEMBER**

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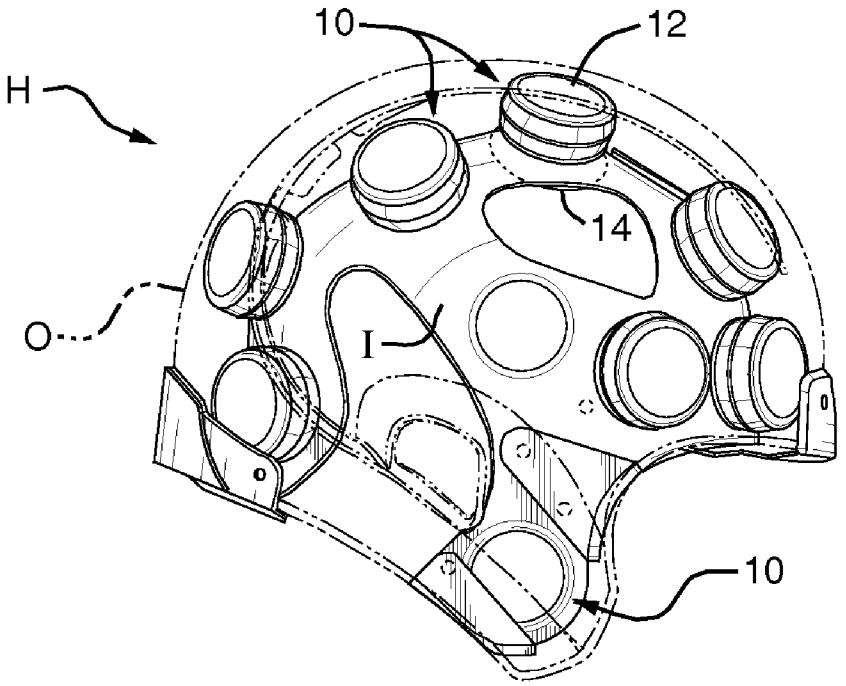
(57) **ABSTRACT**

A protective headgear compression member includes a hollow compression cell having a top wall, a bowed side wall and a bottom wall and a liner element secured to that bottom wall coaxially to said cell. The liner element is composed of a flexible envelope substantially filled with resilient material 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.



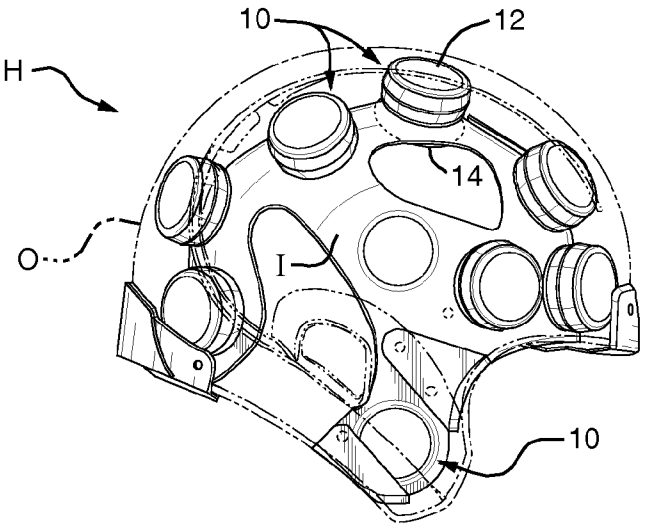


FIG. 1

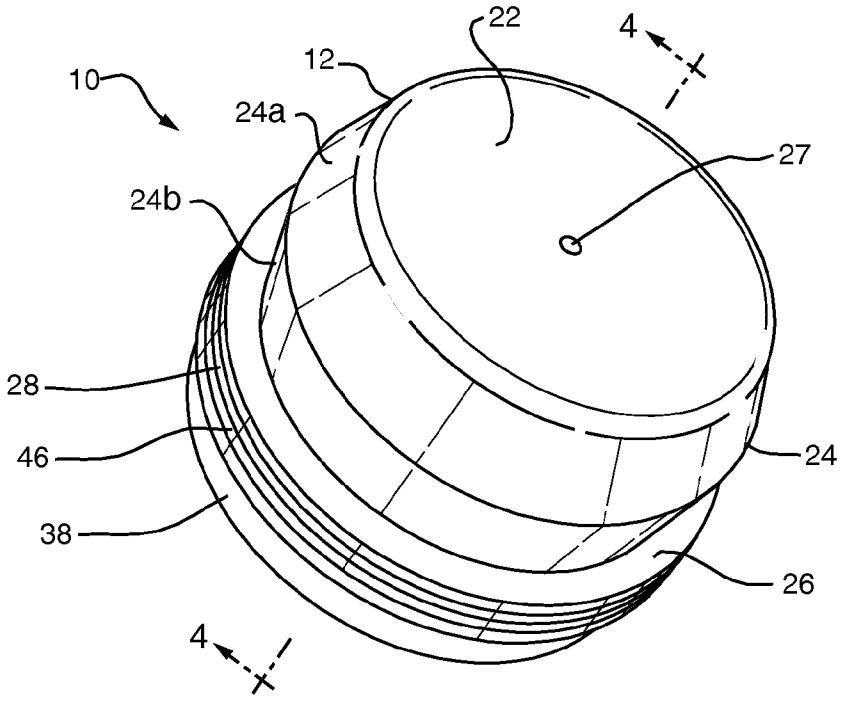
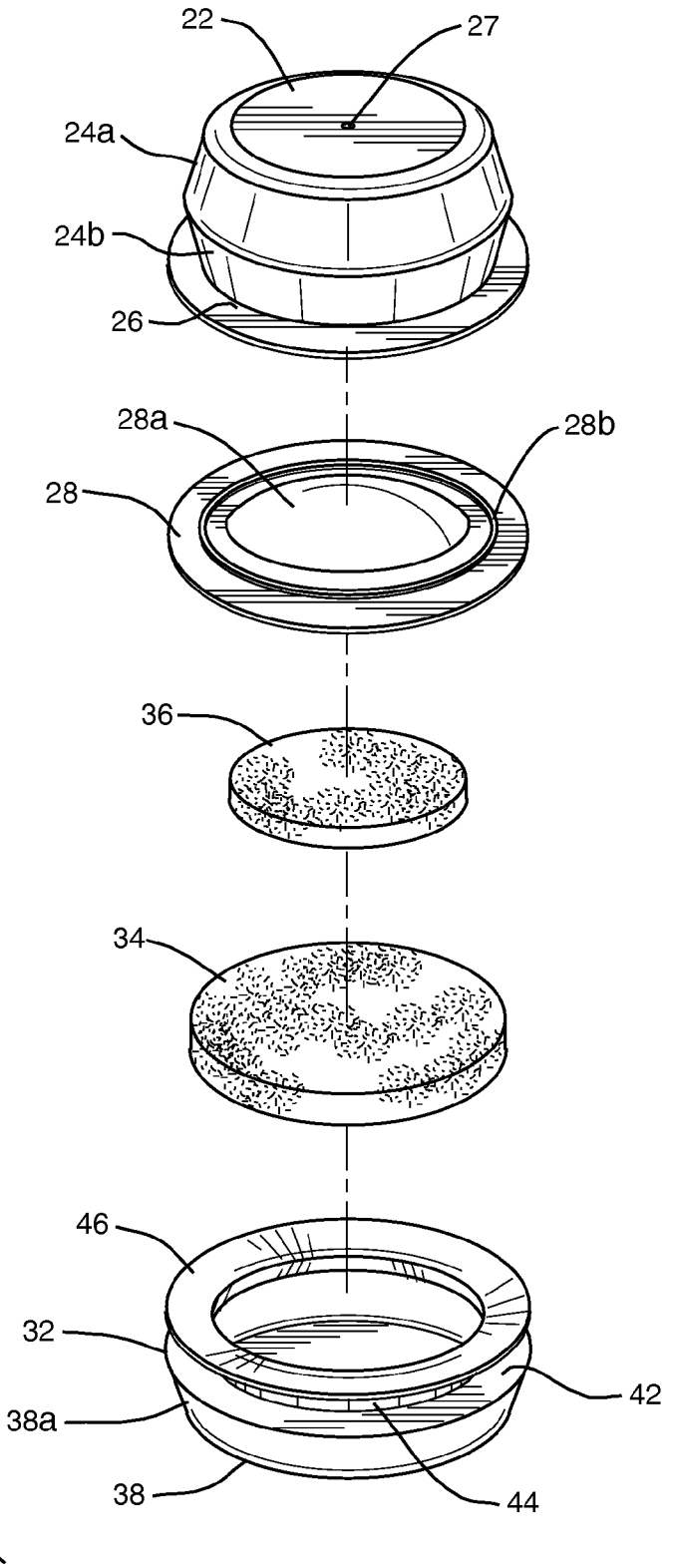


FIG. 2

FIG. 3



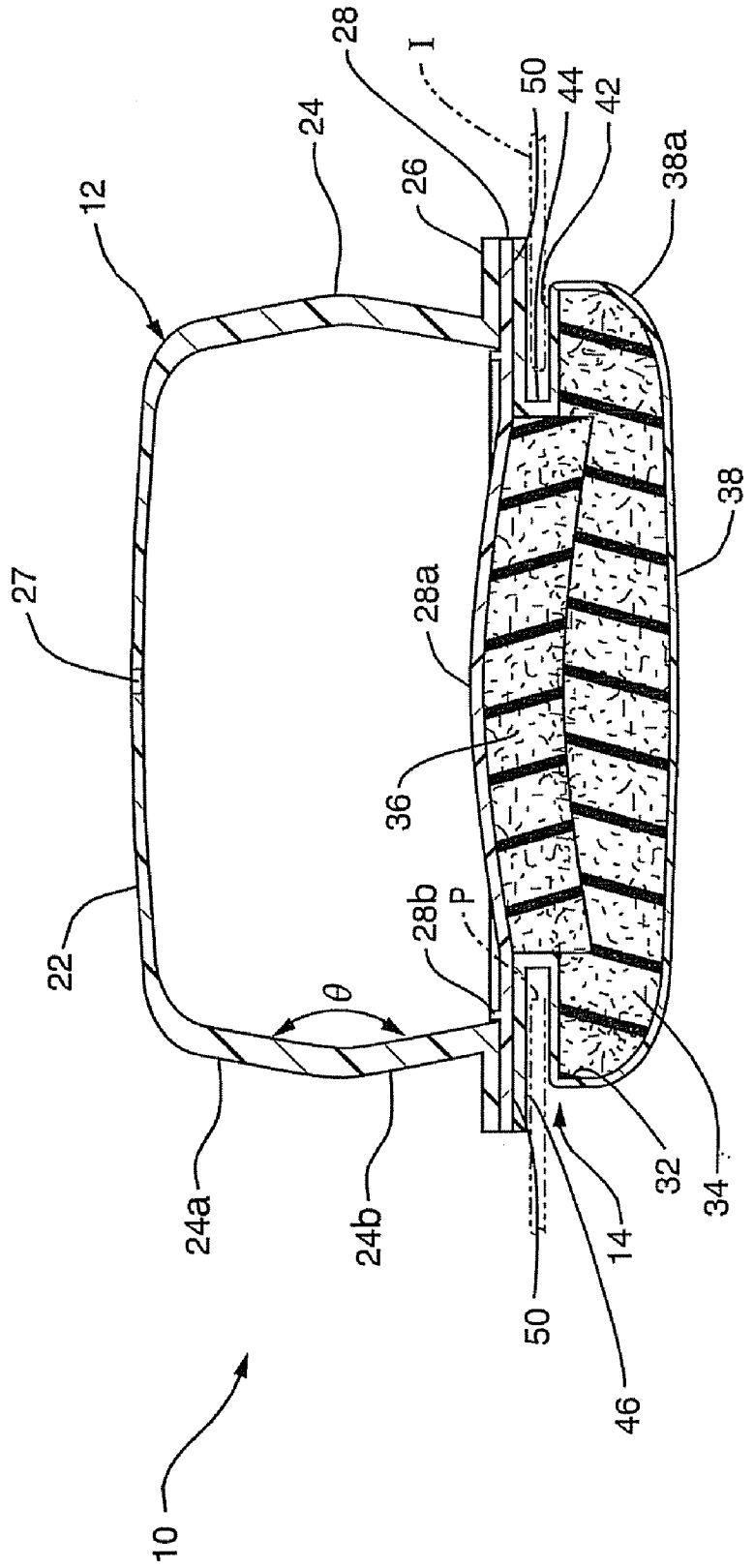

28
I
50
44
42
24
26
38a
12
38
27
28a
36
28b
P
22
θ
24a
24b
32
34
14
50
46
10

FIG. 4

PROTECTIVE HEADGEAR COMPRESSION MEMBER

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] This invention relates to protective headgear and other impact absorbing structures. It relates especially to an impact absorbing compression member for use therein.

[0003] 2. Background Information

[0004] 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 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 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.

[0005] 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 WO2006/089234 and WO2006/089235 and US2007/0190292, published Aug. 16, 2007, the contents of all of which are hereby incorporated by reference herein. 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 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.

[0006] 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 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 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.

[0007] 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 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 OF THE INVENTION

[0008] Accordingly, it is an object of the present invention 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.

[0009] A further object of the invention is 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.

[0010] Another object of the invention is 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.

[0011] Still another object of the invention is 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.

[0012] A further object is to provide such a compressible member composed of a few molded plastic parts which are relatively easy to assemble.

[0013] Other objects 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 invention will be indicated in the claims.

[0014] In general, my 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 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.

[0015] 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 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

[0016] For a further understanding of the nature and objects of the invention, reference should be made to the following detailed description taken in connection with the accompanying drawings, in which:

[0017] FIG. **1** is a side elevational view of a protective helmet incorporating compression members in accordance with this invention;

[0018] FIG. **2** is a perspective view, on a larger scale, showing one of the compression members of the FIG. **1** helmet in greater detail;

[0019] FIG. **3** is an exploded perspective view showing the components of the FIG. **2** compression member in greater detail, and

[0020] FIG. **4** is a sectional view taken along line **3-3** of FIG. **2**.

DESCRIPTION OF A PREFERRED EMBODIMENT

[0021] 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 in response to an impact, and the inner layer I may be of a softer, less rigid material.

[0022] 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 and I and elements **14** collectively form a dynamic inner liner of the helmet.

[0023] 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.

[0024] Each cell **12** comprises a top wall **22**, a bowed side wall **24** composed of a pair of back-to-back frustoconically shaped segments **24***a* and **24***b* and a radial flange **26** extending out from the free lower edge of the segment **24***b*, 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 **24***a* and **24***b*, 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.

[0025] 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 **28***a* 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 **28***b* may be provided on the upper surface of the plate to center the cell on the plate.

[0026] 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**.

[0027] Envelope **32** is of a flexible plastic material such as TPU. It has a circular bottom wall **38** with a gently rounded edge margin **38***a* 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**.

[0028] In accordance with the invention, the bottom wall **38**, **38***a* 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**, **38***a* 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.

[0029] 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**, **38***a*.

[0030] 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 **36** 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**, **38***a* is installed around them.

[0031] 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 **28***a* 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 **28***a*. 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.

[0032] 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**, **38***a* 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** bottom-

ing 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 **28***a* 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 me as small as 1.0 in. when the cell is used in other applications, e.g. as a jaw shock absorber.

[0033] 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.

[0034] It will thus be seen that the objects set forth among those made apparent from the preceding description above are efficiently attained. 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.

[0035] It is also understood that the following claims are intended to cover all of the generic and specific features of the invention described herein.

What is claimed is:

1. A compression member for a protective structure, said 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 coextensive with the flange position and against the underside of the flange, said flange and plate secured together at their peripheries;

a liner element secured coaxially to said cell, said 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 said plate, said second flange being positioned against the underside of the plate and the second flange and plate being secured together at their peripheries, and

a resilient material substantially filling said envelope.

2. The member defined in claim **1** wherein the resilient material is composed of at least two layers having different densities with the least dense layer being adjacent to said bottom wall.

3. The member defined in claim **2** wherein said layers are comprised of plastic foam.

4. The member defined in claim **3** wherein the layers are separate foam pads.

5. The member defined in claim **1** wherein the plate has an upwardly dished central area inboard said cell flange to provide additional clearance for the resilient material adjacent to the plate.

6. The member defined in claim **1** wherein the inner edge of the annular shoulder is connected to the second flange by way of a neck.

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

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

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

* * * * *