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(54) Title: MULTILAYER IMPACT ATTENUATING INSERT FOR HEADGEAR

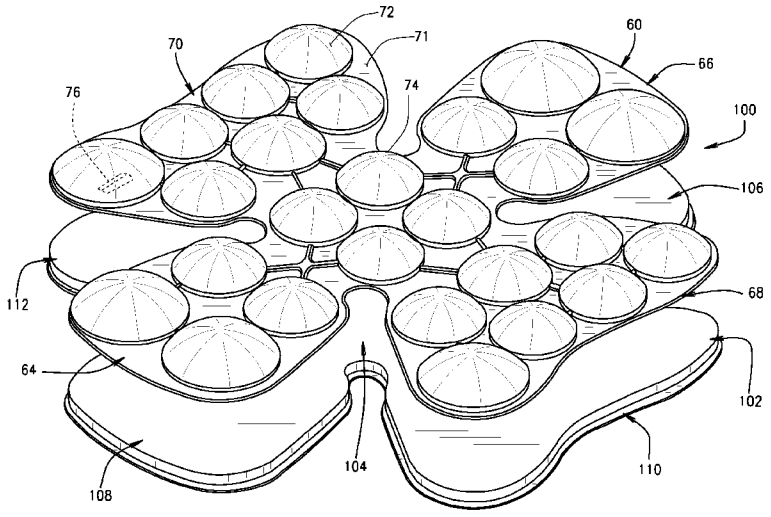

FIG. 11

(57) Abstract: Impact attenuating liner for headgear and headgear employing the liner, the liner positionable inside the headgear and comprising a cellular layer having an array of individual impact attenuating cells, each individual impact attenuating cells including an impact attenuating medium. The impact attenuating cells can comprise a gas, liquid, visco-elastic gel, foam, fiber or combinations thereof as well as other impact attenuating medium. In another aspect, the impact attenuating liner has at least two layers, a cellular layer of and an impact attenuating layer under the cellular. The liner can include a cover. The liner can be removable from the headgear.

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MULTILAYER IMPACT ATTENUATING INSERT FOR HEADGEAR

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims priority to U.S. provisional application Serial No. 61/480,847, filed April 29, 2011 and to U.S. provisional patent application Serial No. 61/521,584 filed August 9, 2011, both of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

The invention relates generally to headgear and more specifically to impact attenuating headgear intended to reduce the incidence or severity of closed head injuries.

Closed head injuries, particularly concussions, are a relatively common occurrence. The term concussion describes an injury to the brain resulting from an impact to the head. By definition, a concussion is not a life-threatening injury, but it can cause both short-term and long-term problems. The terms mild brain injury, mild traumatic brain injury (MTBI), mild head injury (MHI), minor head trauma, and concussion may be used interchangeably. Frequently defined as a head injury with a temporary loss of brain function, concussion can cause a variety of physical, cognitive, and emotional symptoms A mild concussion may involve feeling "dazed" or a very brief loss of consciousness, for example, being "knocked out". A severe concussion may involve prolonged loss of consciousness with a delayed return to normal.

A concussion can be caused by a blow to the head, or by acceleration forces without a direct impact. The forces involved disrupt cellular processes in the brain for days or weeks. Concussions often occur in sports, particularly contact sports such as football or hockey. Military personnel can suffer concussions from direct blows to the head or from the percussion of an explosive device.

Treatment of concussion involves monitoring and rest. Symptoms usually go away entirely within three weeks, though they may persist, or complications may

occur. Repeated concussions can cause cumulative brain damage or severe complications such as second-impact syndrome.

Use of protective equipment such as headgear has been found to reduce the number of concussions in athletes and military personnel. Improvements in the design of protective gear such as helmets may decrease the number and severity of such injuries.

It would be advantageous, therefore, to have protective headgear with enhanced impact attenuating properties.

SUMMARY OF THE INVENTION

Headgear with enhanced impact attenuating properties is provided. The headgear can be provided as a liner for protective headgear, such as a helmet, or as an integral part of the protective headgear.

The headgear comprises an impact attenuating or shock reducing pad which can be employed as a permanent liner or replaceable liner for protective headgear such as a helmet. In one aspect, the pad comprises a flexible base or web having an array of individual cells across the web. The liner is configured to fit within the cavity of an impact resistant shell, such as a helmet. As such the liner is configured so as to be folded and positioned within the helmet. The liner can be reasonably secured inside the helmet shell or integral with the helmet shell.

The individual cells can be air cells. The air cells can be sealed at an optimal internal pressure or can be interconnected by airflow channels so that pressure can be equalized among the cells. The size of the various air flow channels is predetermined can be varied to control the flow of air between the cells at impact to better control the impact attenuating characteristics of the pad.

In another embodiment, the cells can be at least partially filled with another impact attenuating medium such as a visco-elastic material or foam or impact attenuating plastic that has optimal impact attenuating characteristics.

In another aspect, the impact attenuating liner comprises an impact attenuating base and an impact attenuating cellular layer positioned on the base.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of an impact attenuating liner inside headgear;

Fig. 2 is a perspective view of an impact attenuating headgear liner;

Fig. 3 is a top plan view of the impact attenuating liner;

Fig. 4 is a side elevational view thereof;

Fig. 5 is a front plan view thereof;

Fig. 6 is a rear plan view thereof;

FIG. 7 is a top plan view of another aspect of an impact attenuating headgear liner;

FIG.8 is a perspective view of another aspect of an impact attenuating headgear liner;

FIG. 9 is a top plan view thereof;

FIG. 10 is a perspective view of another aspect of an impact attenuating headgear liner;

FIG 11 is a perspective view of a multilayer impact attenuating headgear liner;

FIG. 12 is a top plan view of the multilayer impact attenuating liner of FIG. 11 inside headgear; and

FIG. 13 is a perspective view of one embodiment of a manual inflation pump.

DETAILED DESCRIPTION

One embodiment of the impact attenuating headgear is indicated generally by reference numeral 10. The illustrated headgear comprises an outer shell 12 defining an inner cavity 14. There is an impact attenuating pad or liner within cavity 14. Cavity 14 is sized and configured such that a wearer's head is snugly and comfortably nestled within the cavity and surrounded by the liner, as will be explained.

It will be noted that outer shell 12, as illustrated, is commonly referred to as a helmet. The illustrated embodiment is configured as a military type helmet. The outer shell, however, can be any type of helmet including, but not limited to, a

football helmet, racing or motorcycle helmet, bicycling helmet, baseball batter's helmet, hockey, skiing, or the like. It will be understood that any reference to an outer shell or helmet or headgear herein is intended to encompass any type of protective headgear presently known or developed in the future.

In general, outer shell 12 is impact resistant, in that it comprises a hard material that resists penetration or breaking, cracking or shattering upon impact. Although no material is absolutely impact resistant, the material comprising the outer shell will be referred to as impact resistant in the general sense. Such materials include, but are not limited to, synthetic fiber materials such as Kevlar® high impact plastics, fiberglass or metal.

Impact attenuating pad or liner 16 comprises a base 18, which is constructed as a flexible web. There is an array 20 of individual, upstanding cells 21 across the web. The liner can be constructed with cells 21 molded into an upper or top sheet, or conformal, which is then adhered to a bottom or backing sheet. The bottom sheet and the material around the cells form a flexible web. However, the impact attenuating pad can be formed or molded or constructed in any acceptable manner.

Cells 21 are referred to as impact attenuating cells in that they absorb forces exerted against the cells resulting from impact to the outer shell or jarring or shaking movement of the wearer's head. In one embodiment, cells 21 are upstanding inflatable cells. Many of the cells are substantially rectangular, while others are triangular and others trapezoidal in peripheral configuration. The configuration of the cells allows the liner to be folded into place within the helmet without any gaps between impact attenuating cells. In any event, the upstanding cells include a top wall 22 and side walls 23 around the periphery of the cell. The cells can be filled with a gas, such as air, to a desired pressure and sealed.

In other aspects, the cells can be partially or fully filled with another impact attenuating material, such as liquid or foam or visco-elastic material or combinations thereof. In one aspect of the liner the cells are about ¾ inch high when fully functional.

In the illustrated embodiment, cells 21 can be interconnected by air flow pathways or conduits 24 extending through base 18. The interconnected cells can have enhanced impact attenuating properties since the pressure within the cells can be equalized. Moreover, if there is impact at one area of the cells, air within those cells will be forced through the air conduits to better absorb the force. The cross-sectional area of conduits 24 may be varied among the cells to enhance or control the shock or force absorbing characteristics of the cells by controlling the egress of air out of the cells upon the application of force. As seen in Fig. 1, liner 16 includes an inflation valve 25 that is in fluid communication with the cells. The wearer can optimally inflate the base for a snug fit, either by inflating the cells and donning the helmet or by donning the helmet then inflating the cells until the desired fit is achieved.

In one embodiment, the base and cells comprise a dip molded neoprene material which has optimal pressure dispersing characteristics. The base and cells also can be a cavity molded polyurethane or other appropriate material.

In alternative embodiments, the base and cells can be molded from urethane or similar materials. Cells 21 can contain or be filled with, or fashioned from, other impact attenuating material, such as visco-elastic gel, or foam or the like. Moreover, some of the cells can be air cells and others can be gel or foam filled cells. In other embodiments, the cells are not filled with gel or foam, but the cell itself is constructed of gel or foam.

The liner has major components that are intended to provide impact attenuation at primary areas of a wearer's skull when folded and positioned within the cavity of the protective shell. Liner 16 includes a central section 26 that is positioned at the midline of the protective shell and extends the length of the liner and extends from the frontal area, over the parietal area and to the occipital area of the skull of the wearer. There is a forward section 28, having side flaps 28A and 28B at the first or front end of the central section that is positioned across the frontal area of the skull. At the approximate midpoint of the central section there is a first temporal pad 30 and an opposed second temporal pad 32. At the rear or second end

of the central section is rear section 34, having side flaps 34A and 34B that is position over the occipital area of the wearer's skull.

As seen from Fig. 1, liner 16 is configured such that it can be folded and optimally positioned within cavity 14. Hence base 18 includes a plurality of appropriately located fold lines 34 between the major sections described above. The air conduits 24 extend through fold lines 25 without collapsing when folded.

Another aspect of a liner, indicated generally by reference number 40, is shown in FIG. 7. Liner 40 includes a base 42 with an array of individual upstanding, impact attenuating cells 44 on the base. The cells are upstanding and include a peripheral side wall 45 and a top wall 46. In one aspect, the cells are about ¾ inch high when functional. Liner 40 has a substantially cruciform peripheral configuration and comprises a center section 47, a forward section 48, a rear section 49, a first side section 50 and a second side section 52. The side sections may be referred to as wings or temporal pads.

Cells 44 in the center, front and rear sections are substantially rectangular in peripheral configuration. The cells comprising first and second side sections 50 and 52, respectively, have varied configurations. As shown, the cells in the temporal pads are configured to define cut-outs or arches 54 and 56 positioned such that the liner does not impinge on the wearer's ears and hearing when position in a helmet.

As previously described, cells 44 of liner 40 may be partially or totally filled with a gas, such as air, or filled or partially filled with another impact attenuating material such as a liquid, foam, a visco-elastic material, an impact attenuating plastic or the like. In any event, cells 44, containing a gas or another flowable medium, such as liquid, are interconnected by fluid flow conduits 58 to equalize the pressure among the cells in use. The conduits may be varied in size to control fluid flow patterns, as described above.

Liner 44 may be sealed or include an air valve 59, which can be a self-inflating valve or even a valve and pump combination. The valve 59 (or pump/valve, or a self-adjusting valve as disclosed in the assignee's co-pending provisional application Serial No. 61/408,774, which is incorporated herein by reference) is

located on one of the side sections so that it is easily reached when installed in a helmet and placed on the head. Also, by placing valve 50 at this position, it does not contact the head if the helmet is struck by a projectile or jarred by concussive force. In use, the helmet and liner is place on the head and inflated. The user then manipulates valve 59 to allow some deflation until the helmet is optimally positioned on the head.

FIGS. 8 and 9 illustrate another aspect of a liner, indicated generally as reference number 60, Liner 60 also has a substantially cruciform configuration and includes a center section 62, a forward section 64, a rear section 66, a first side section 68 and a second side section 70. Liner 60 comprises a base 71 with an array of individual upstanding, impact attenuating cells 72 on the base. The cells 70 have a substantially circular peripheral configuration and a rounded or domed cross-section. Cells 70 are about ¾ inch high at the top when fully functional. The cells are interconnected by fluid flow conduits 74, as previously described, and may be totally fluid filled or partially fluid filled or totally filled with another impact attenuating material or combinations thereof, as described above. One of the cells may incorporate a valve, a self-adjusting valve or pump, as at 76, or as shown in Fig. 13. The air pad layer could also be pre-sealed during manufacture with a set amount of air so that it is not adjusted by the user.

FIG. 10 illustrates another aspect of a liner, indicated generally by reference number 80. Liner 80 has a substantially cruciform peripheral configuration and includes an array of individual, upstanding dome-shaped cells 82. The cells are interconnected by a web 84 that includes internal fluid flow conduits. Web 84 defines a plurality of open areas 86 spaced between the cells. These open areas reduce the material weight of liner 80 and promote ventilation. The cell and web structure is arranged with a center section 87, a forward section 89, a rear section 90, a first temporal pad 92 and a second temporal pad 94.

It should be noted that open spaces 86 may be filled with other, light weight material, such as light weight foam. Or, as will be explained hereinafter, liner 80 may

be positioned on a pad. Appropriately configured surfaces of the pad may protrude into open areas 86 between the cells.

The dome shaped cells of liners 60 and 80 offer significant advantages. As mentioned above, the liner is secured in the helmet, deflated, placed on the head and then inflated for proper fit. In some circumstances, cells with a top wall and peripheral side wall will collapse when deflated. However, the side walls buckle or fold and the folded or wrinkled cell material support the helmet on the head. It is difficult to get a proper fit or feel. On the other hand, when domed cells are deflated, the collapse inwardly without the wrinkling or folding, allowing for a better feel and a better fit upon inflation.

FIGS. 11 and 12 illustrate another aspect of the impact attenuating liner. As seen, the liner is a multi-layer liner, indicated generally by reference number 100, comprising a cellular layer, in this illustration the inflatable layer being liner 60 shown in Fig. 8 with its constituent parts. It will be understood that any of the previously described cellular liners may be employed in the multilayer liner. The multilayer liner 100 also includes a base layer 102. Base layer 102 is an impact attenuating layer comprising an impact attenuating material such as an appropriate liquid, foam, visco-elastic material, impact attenuating plastic such as Isoblox® (theDODDgroup, Allen, Tx), fiber, either synthetic or natural, or any other material that has appropriate impact attenuating characteristics at the appropriate and useful dimensions.

Moreover, base layer 102 can comprise another cellular layer with different impact attenuating characteristics than cellular liner 80. In any event, base layer 102 has the same peripheral configuration as cellular liner 60 and includes a center 104, a front section 106, a rear section 108, a first temporal section 110 and a second temporal section 112. In one aspect, cellular layer 60 is slightly undersized in width and length compared to base layer 102 so that when both layers are folded or configured to fit inside a helmet 12 the layers have coextensive peripheral edges, as shown in FIG. 12.

In one aspect, the multi-layer liner 100 is approximately 7/8 inch in thickness from the bottom surface of the base to the top of the functional cells.

Base layer 102 can have a cover and/or both layers together can be covered. In one example, the cover could have two pockets, one to hold the base layer and another to hold the cellular layer.

In another aspect, cellular layer 60 may be attached or bonded to base layer 102, for example by spot welds or hook and loop fastener (Velcro®) or any other means to keep the layers in alignment in use.

Although base layer 102 is shown as a contiguous sheet, it can comprise discrete segments of impact attenuating material that are hinged or otherwise flexibly attached together to allow it to bend or flex to fit properly within the helmet. Or, base layer 102 may comprise a cover or container that encloses a plurality of chunks or granules or pieces of impact attenuating material.

One embodiment of an acceptable pump assembly is shown in Fig. 13 and indicated by reference number 120. Pump assembly 120 includes web 122 with a diaphragm pump or other acceptable pump (not seen) inside a cell 124. Cell 124 is configured to be integrated into web 122 in place of one of the cells described above or just ancillary to the cells. Pump assembly 120 includes a release valve 126 and appropriate fluid flow connection 128 to an adjacent air cell to allow inflation of the air cells by manipulation of the pump. The user can don the helmet, actuate the pump until snug and release air, if necessary, through release valve 126. Pump assembly may include other apparatus such as a check valve and manual inflation valve to allow inflation by an outside air source. Other aspects of acceptable pumps are shown in U.S. Patent No. 5,074,765.

The foregoing description of the various embodiments is intended to be illustrative of the broader aspects of the present invention and should not be construed in a limiting sense.

CLAIMS:

1. An impact attenuating liner for headgear comprising:

an impact attenuating cellular layer having a base with an array of individual impact attenuating cells on the base, each individual impact attenuating cell comprising an impact attenuating medium, said cellular layer configured to fold and fit within the headgear.

2. The liner of claim 1 wherein the impact attenuating medium is a gas within the cells.

3. The liner of claim 2 wherein the cellular layer comprises and integrated pump.

4. The liner of claim 1 wherein the impact attenuating medium is a gas and a second impact attenuating medium.

5. The liner of claim 2 wherein the cellular layer base further comprises a plurality of air flow paths of a predetermined volume interconnecting the cells.

6. The liner of claim 5 wherein the predetermined volume of at least a portion of the plurality of air flow paths is greater than the predetermine volume of at least another portion of the plurality of air flow paths.

7. The liner of claim 1 wherein the liner is removably secured within the headgear.

8. The liner of claim 1 wherein the impact attenuating medium is a visco-elastic gel.

9. The liner of claim 1 wherein the impact attenuating medium is polyurethane foam.

10. The liner of claim 3 wherein the second impact attenuating medium is selected from a group of impact attenuating media consisting of liquid, foam, visco-elastic material, plastic, synthetic fiber, natural fiber, and combinations thereof.

11. The liner of claim 1 comprising a central section positioned at the midline of the headgear a frontal section positioned to correspond to a frontal

area of a wearer's skull, a first temporal area and an opposed second temporal area, and a rear section positioned to correspond to an occipital area of a wearer's skull.

12. The liner of claim 1 wherein the liner comprises a second impact attenuating layer positioned adjacent the base of the cellular layer.

13. The liner of claim 12 wherein the second impact attenuating layer comprises an impact attenuating medium selected from the group consisting of liquid, foam, visco-elastic material, plastic, synthetic fiber, natural fiber, and combinations thereof.

14. An impact attenuating liner for headgear comprising:

an impact attenuating cellular pad positionable within the headgear, said cellular pad comprising a base with an array of individual impact attenuating cells on the base, each individual impact attenuating cell comprising an impact attenuating medium; and

an impact attenuating layer adjacent the base of the cellular pad.

15. The liner of claim 14 further comprising a cover.

16. The liner of claim 14 wherein the cellular pad comprises a pump.

17. The liner of claim 14 wherein the impact attenuating layer is complementary in peripheral configuration to the cellular pad and the layer and the cellular pad are configured to be foldable and positionable within the headgear.

16. The liner of claim 14 wherein the impact attenuating layer comprises an impact attenuating medium selected from the group consisting of liquid, foam, visco-elastic material, plastic, synthetic fiber, natural fiber, and combinations thereof.

19. The liner of claim 14 wherein the cellular pad is affixed to the impact attenuating layer.

20. Impact attenuating headgear comprising:

an outer shell defining an inner cavity;

an impact attenuating liner within the inner cavity, said liner comprising

an impact attenuating base layer and a cellular layer on the base layer, the cellular layer comprising an array of individual impact attenuating cells, each individual impact attenuating cell comprising an impact attenuating medium selected from the group of impact attenuating media consisting of air, liquid, foam, visco-elastic gel, plastic, fiber and combinations thereof.

21. Impact attenuating headgear of claim 20 further comprising a cover over at least the base layer.

22 Impact attenuating headgear of claim 20 wherein the cellular layer comprises inflatable air cells and a pump.

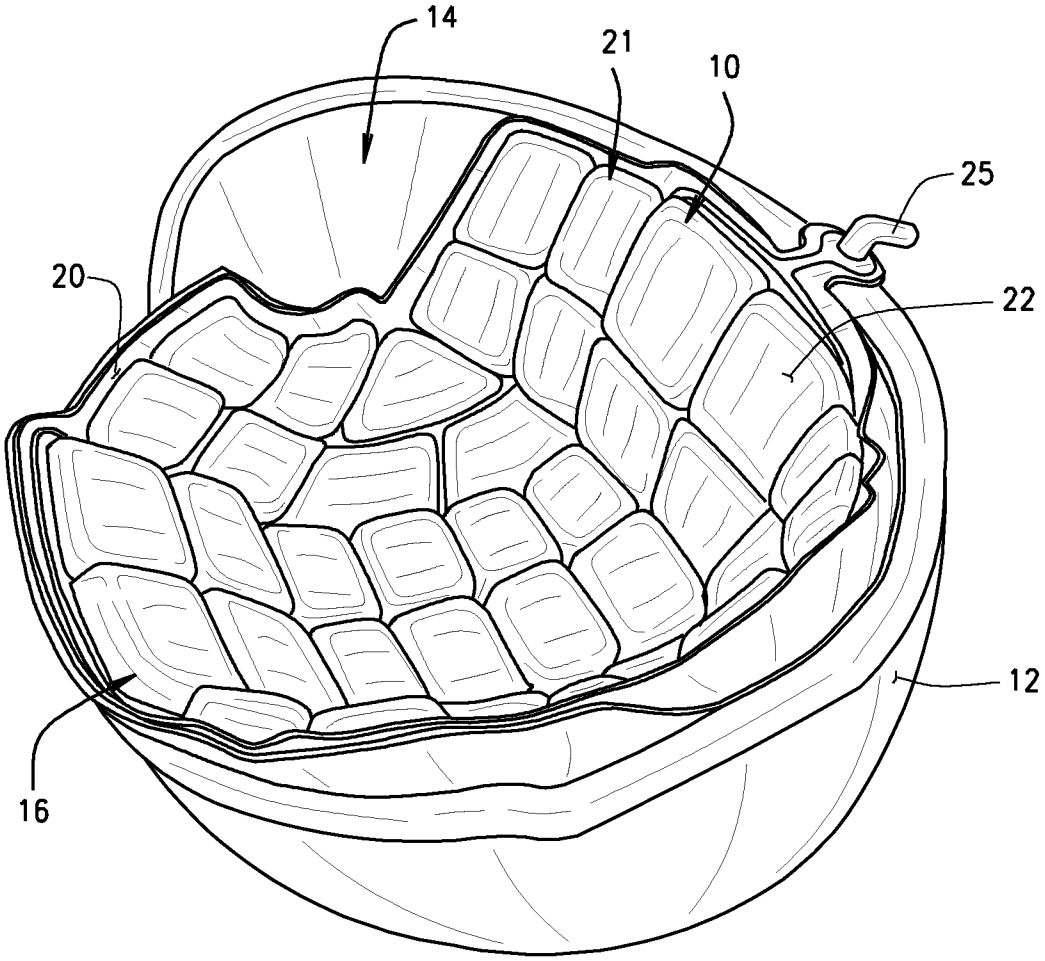

FIG. 1

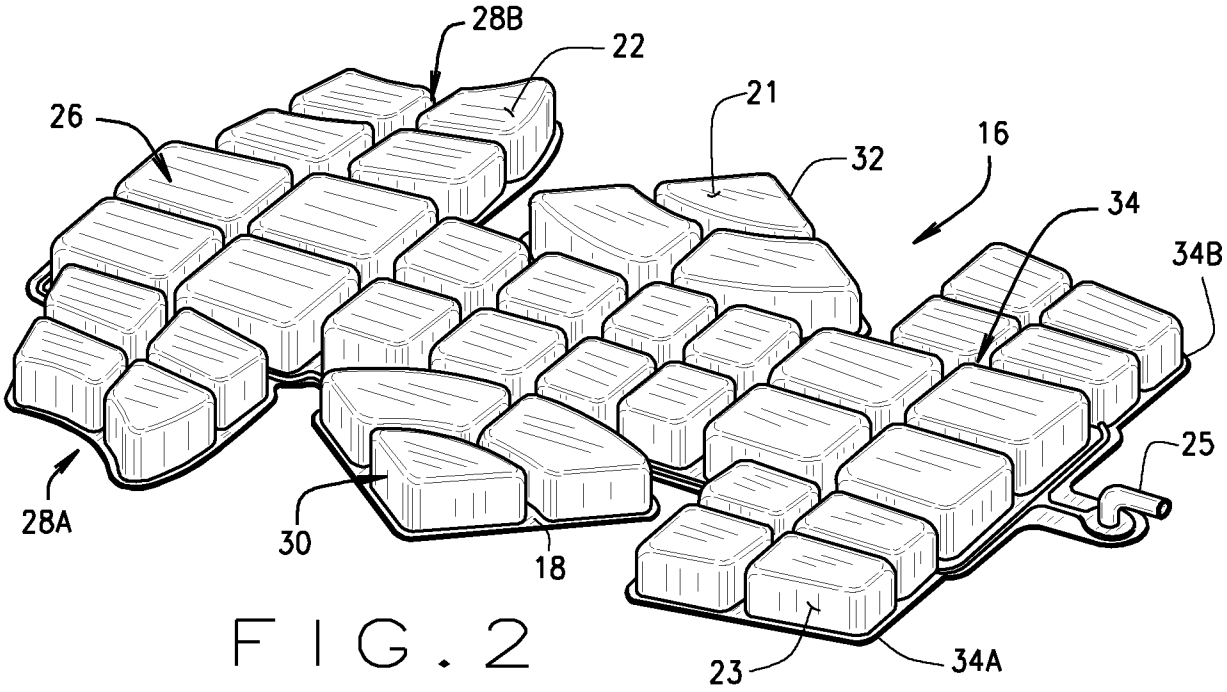

FIG. 2

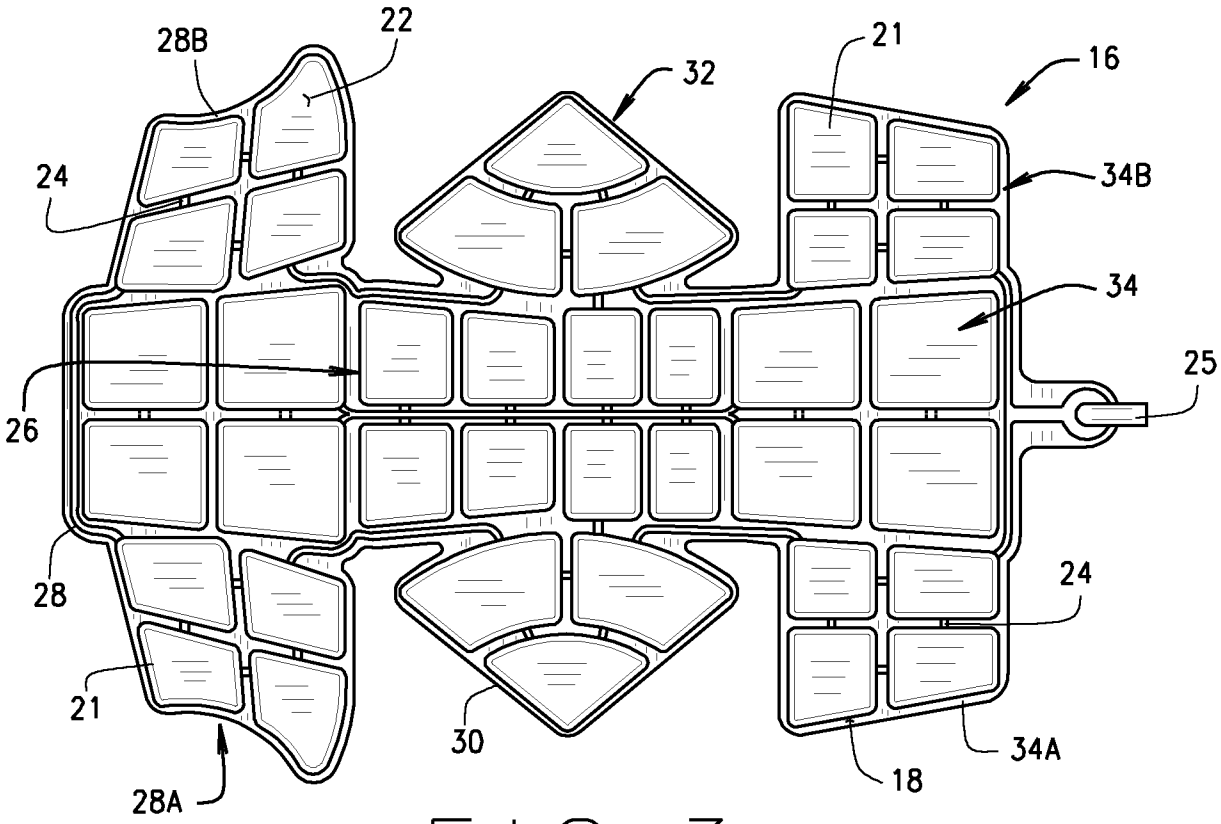

FIG. 3

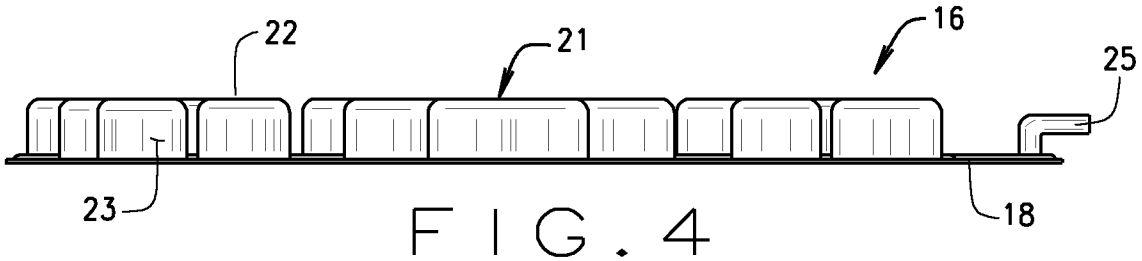

FIG. 4

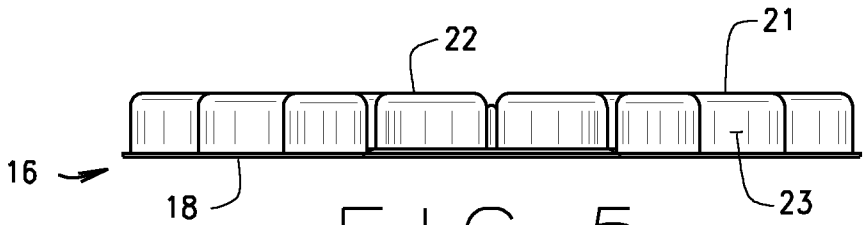

FIG. 5

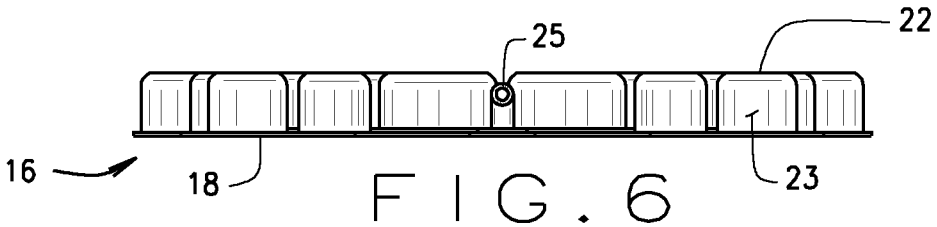

FIG. 6

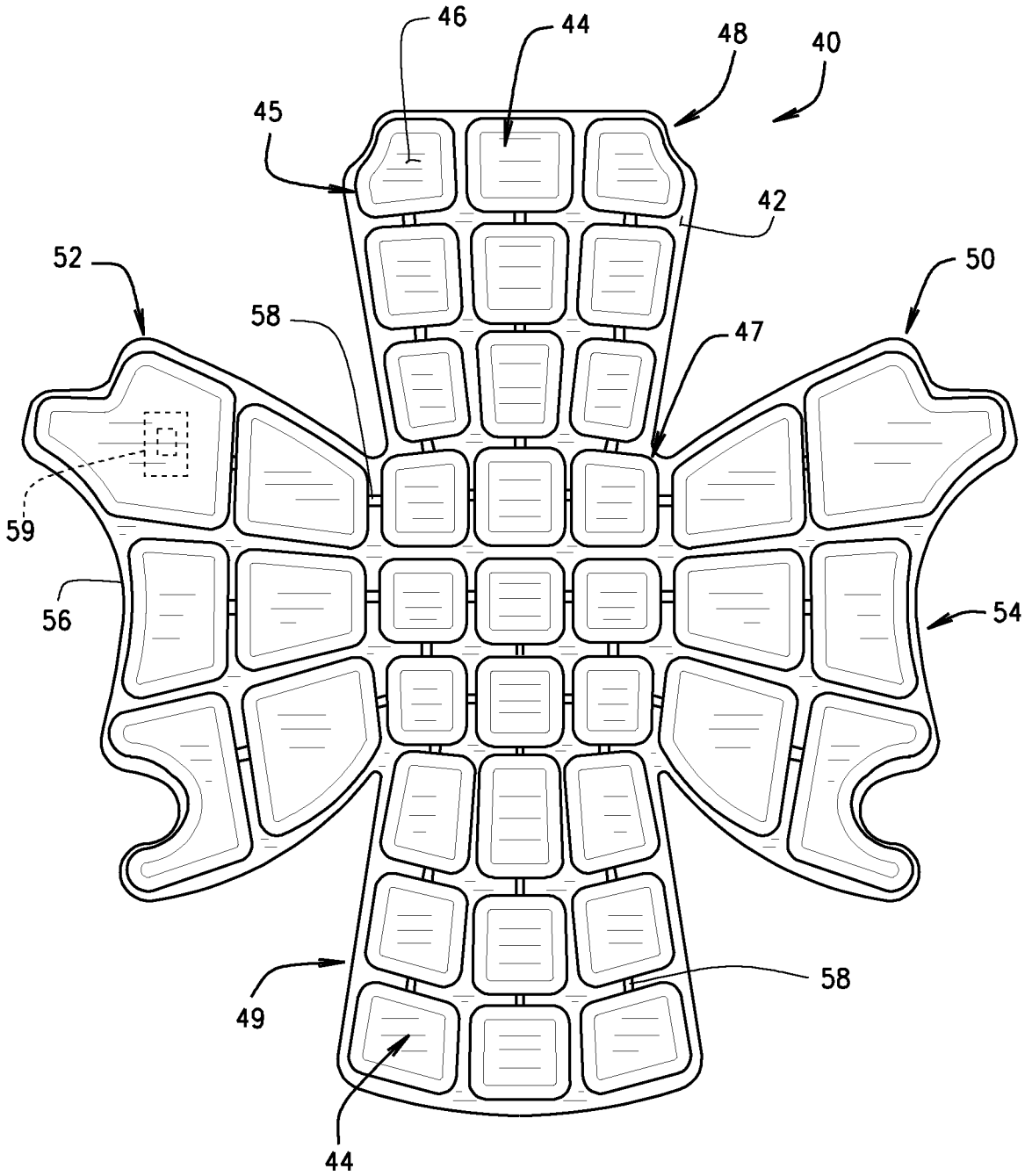

FIG. 7

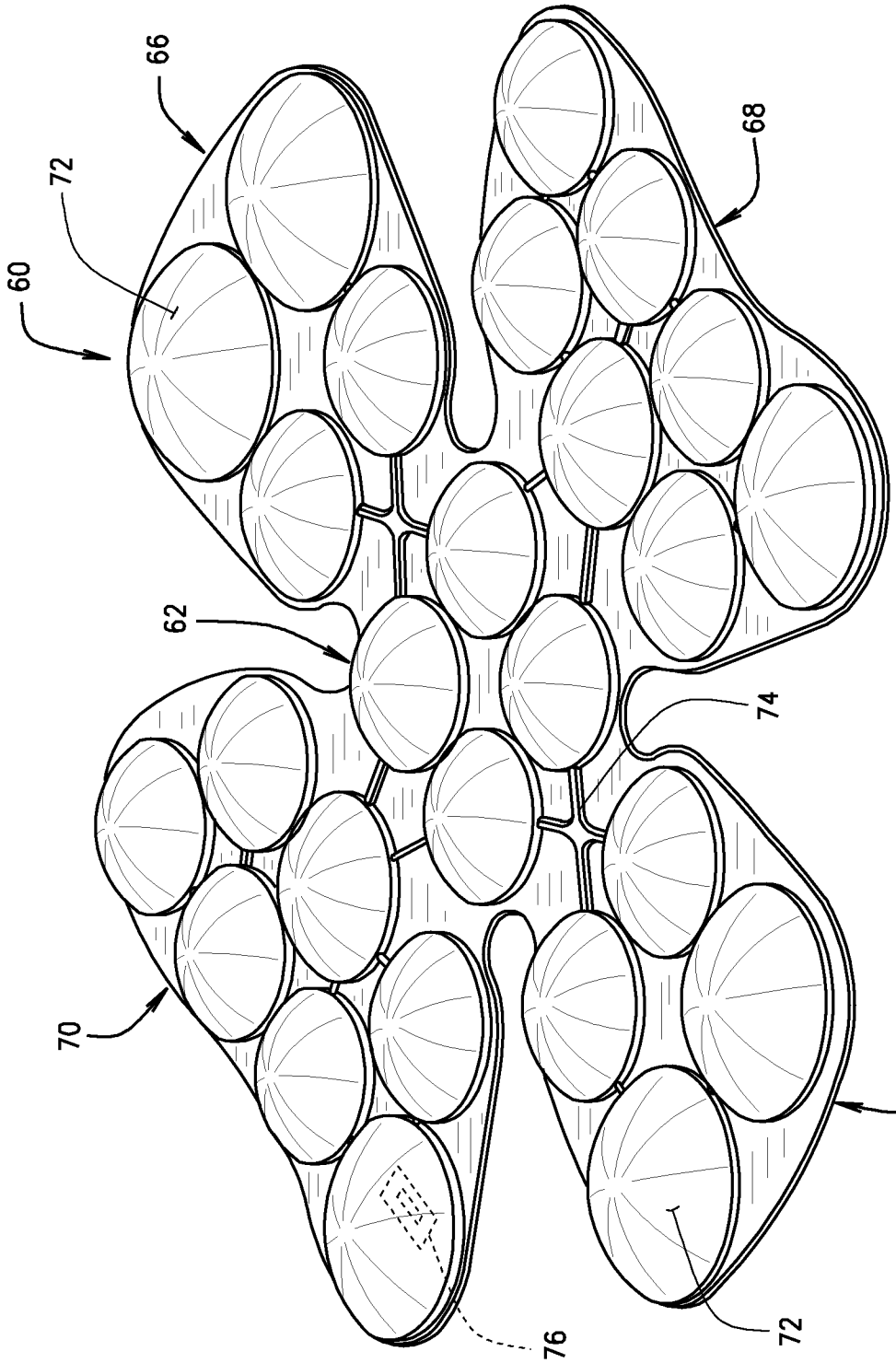

FIG. 8

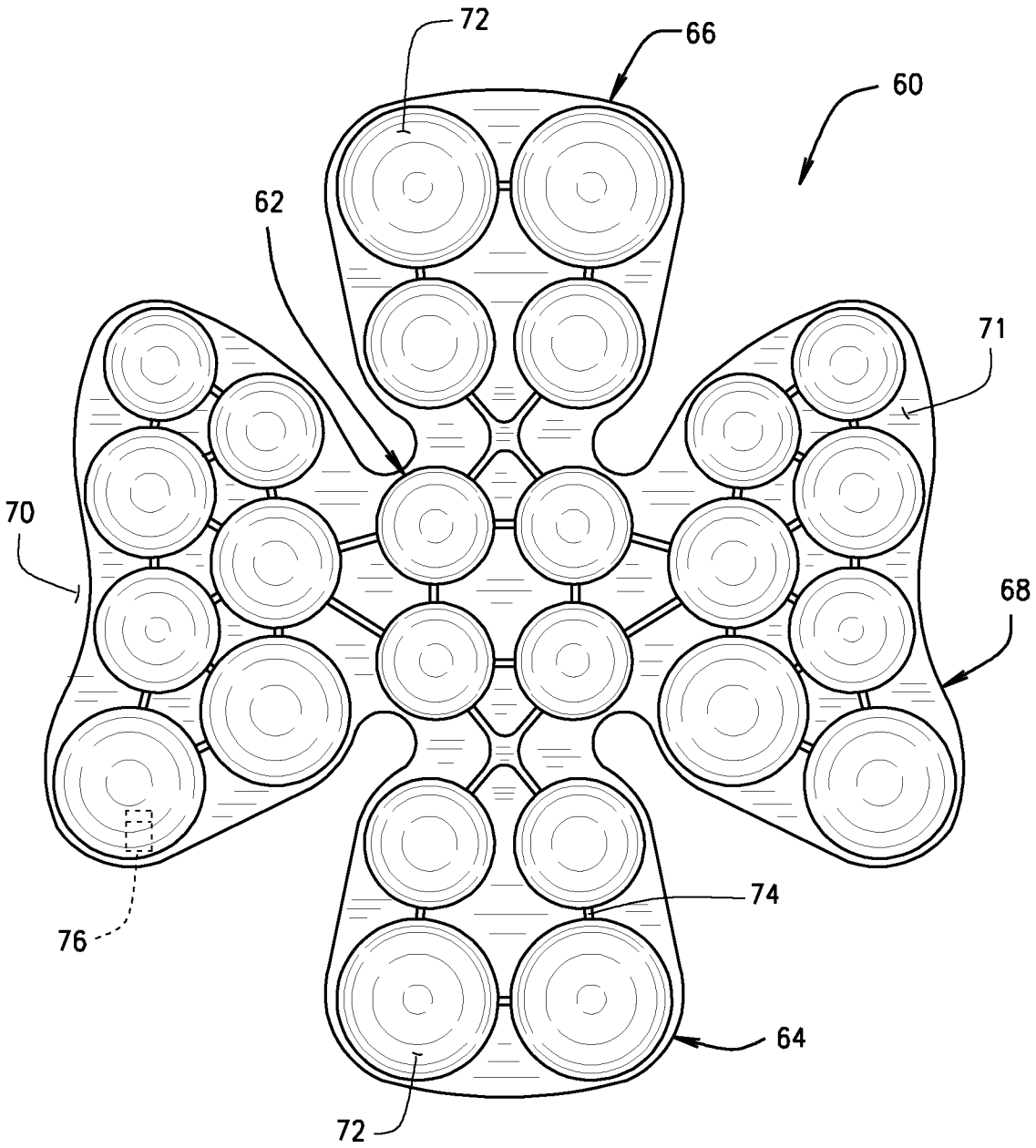

FIG. 9

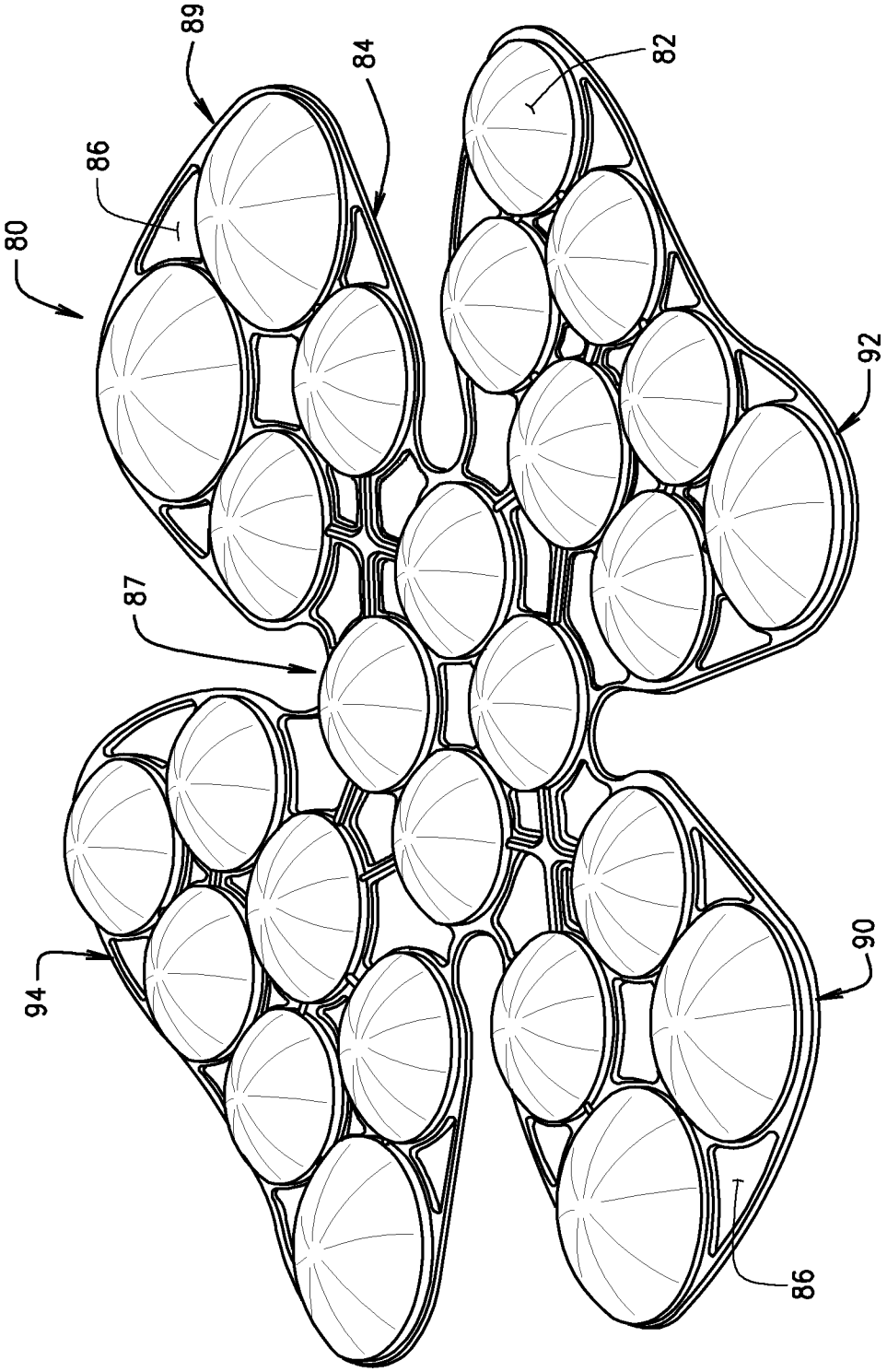

FIG. 10

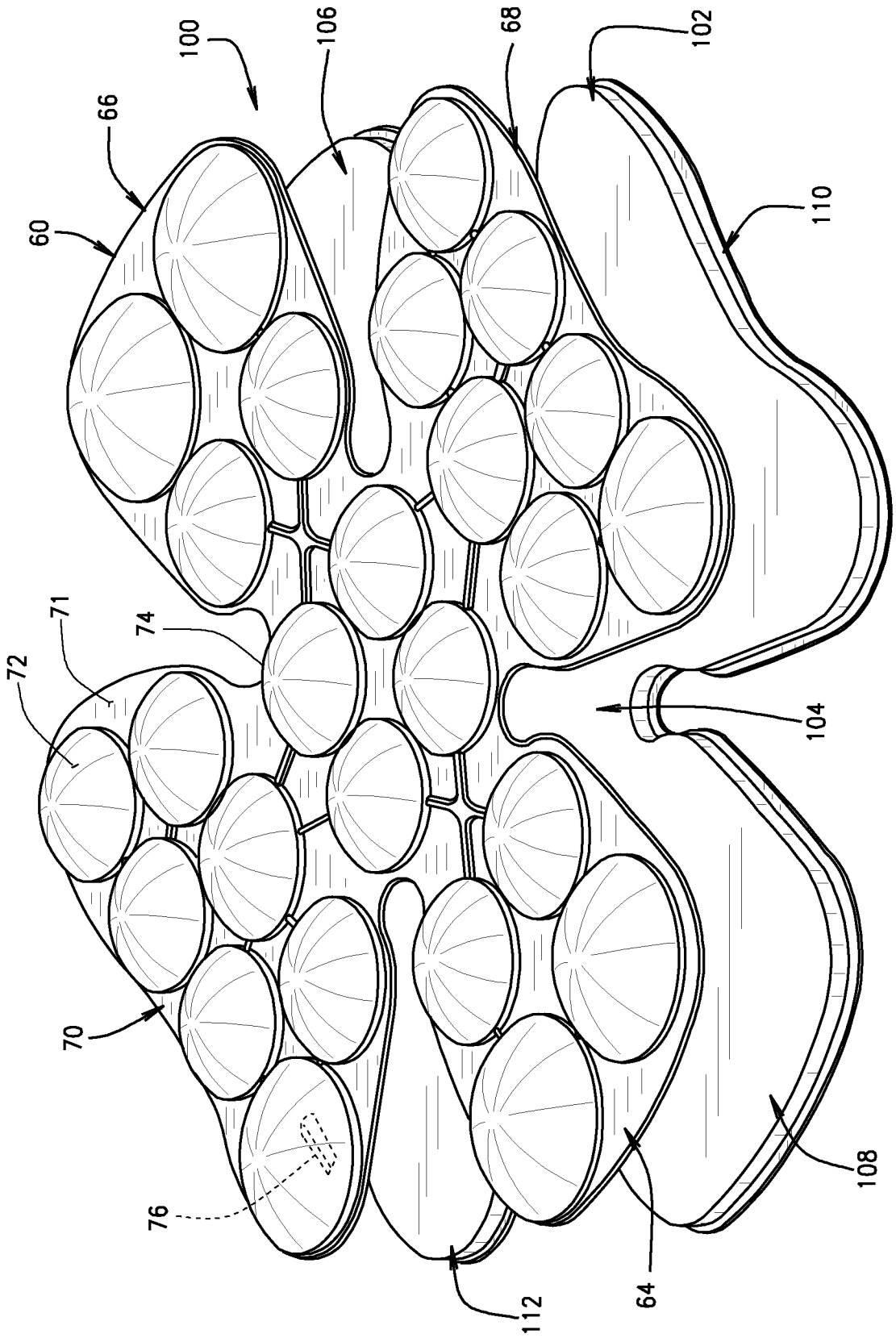

FIG. 11

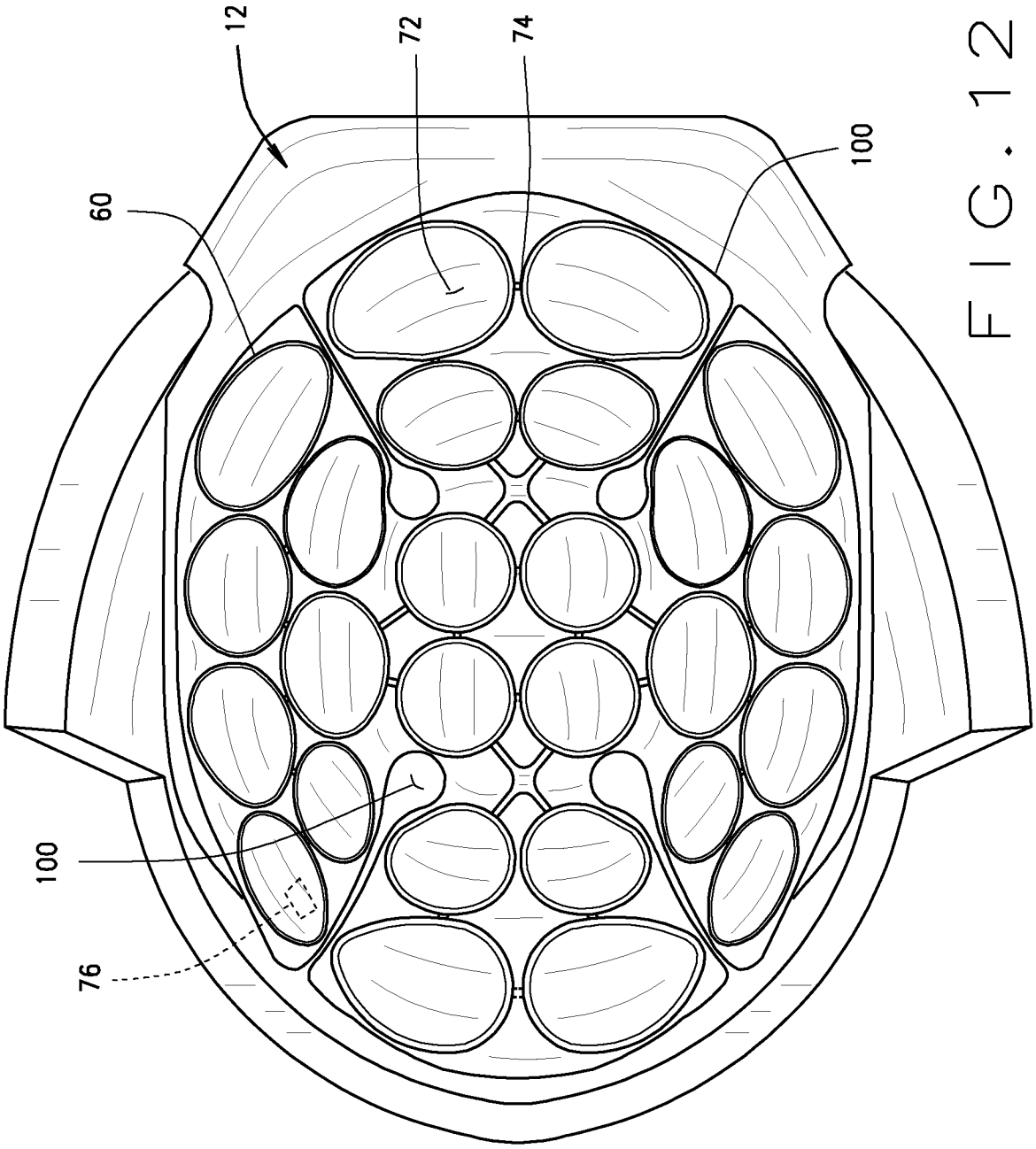

FIG. 12

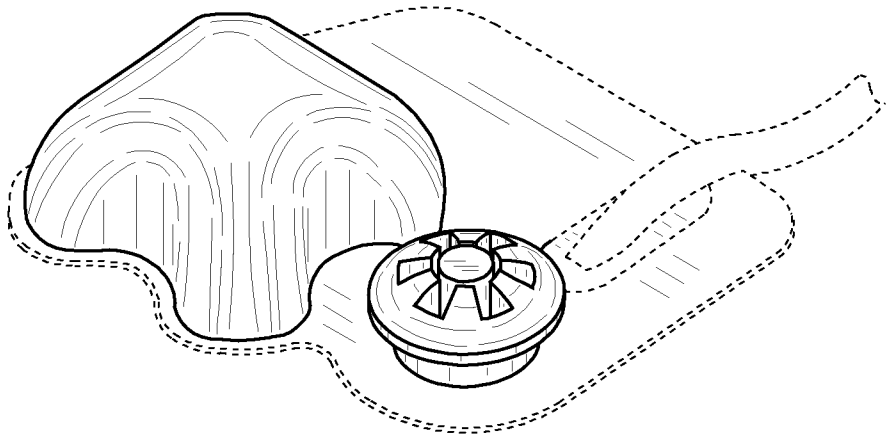

FIG. 13