



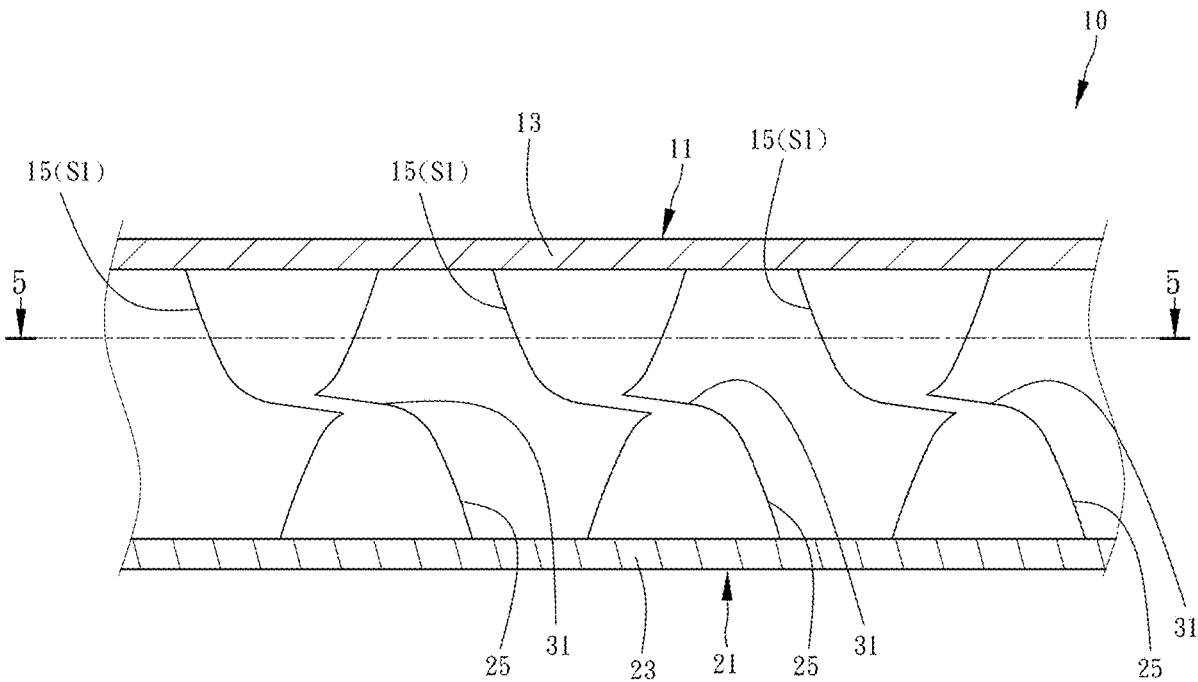
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(19) **United States**(12) **Patent Application Publication**
LIU et al.(10) **Pub. No.: US 2021/0007434 A1**(43) **Pub. Date: Jan. 14, 2021**(54) **HELMET LINER****Publication Classification**(71) Applicant: **NATIONAL CHUNG CHENG UNIVERSITY, CHIA-YI COUNTY (TW)**(51) **Int. Cl.**
A42B 3/12 (2006.01)(52) **U.S. Cl.**
CPC **A42B 3/125** (2013.01)(72) Inventors: **DE-SHIN LIU, CHIA-YI COUNTY (TW); TZU-HAO CHEN, CHIA-YI COUNTY (TW); CHIA-SHAM CHIEN, CHIA-YI COUNTY (TW)**(57) **ABSTRACT**

A helmet liner includes an outer protective layer, an inner protective layer and a plurality of breakable connecting members. The outer protective layer has a first base layer and a plurality of first bulges. The plural first bulges are provided on the first base layer and located at the inner side of the first base layer. The inner protective layer has a second base layer and a plurality of second bulges. The plural second bulges provided on the second base layer and located at the outer side of the second base layer. The plural connecting members are connected between the first bulges and the second bulges so as to endow the helmet liner with reliable impact-absorbing capacity and ensure safety of helmet wearers.

(21) Appl. No.: **16/547,291**(22) Filed: **Aug. 21, 2019**(30) **Foreign Application Priority Data**

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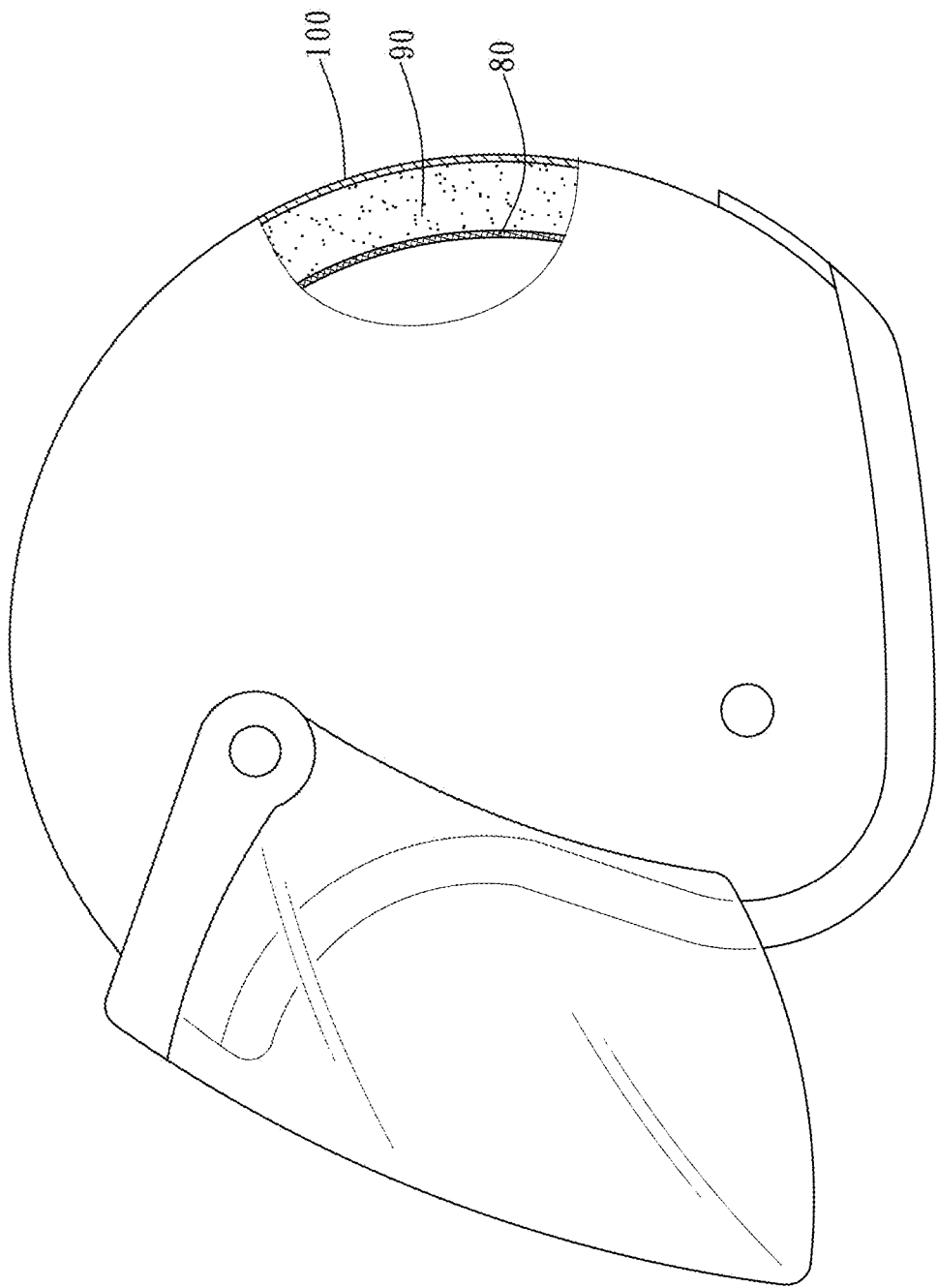


FIG. 1
PRIOR ART

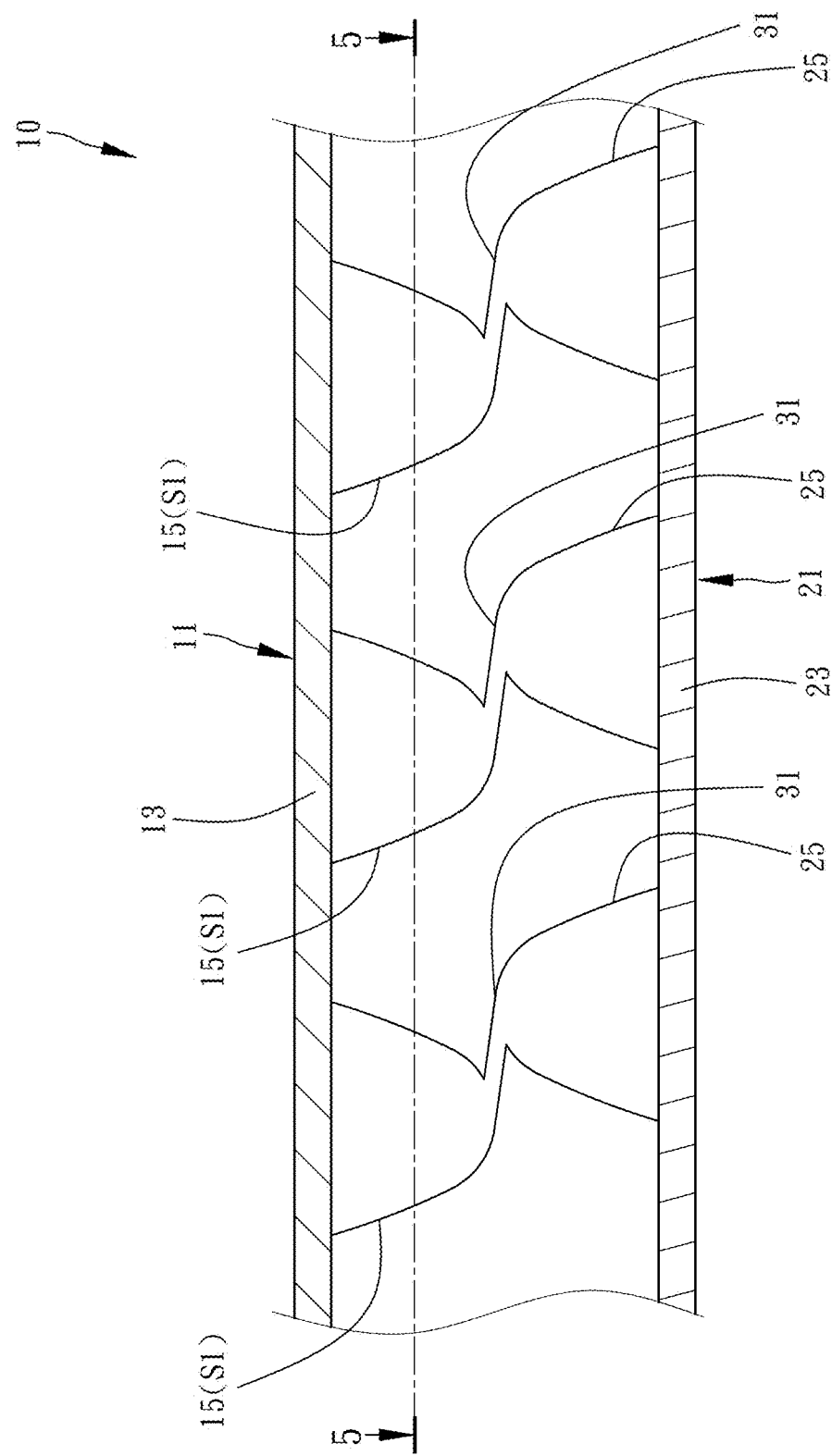


FIG. 2

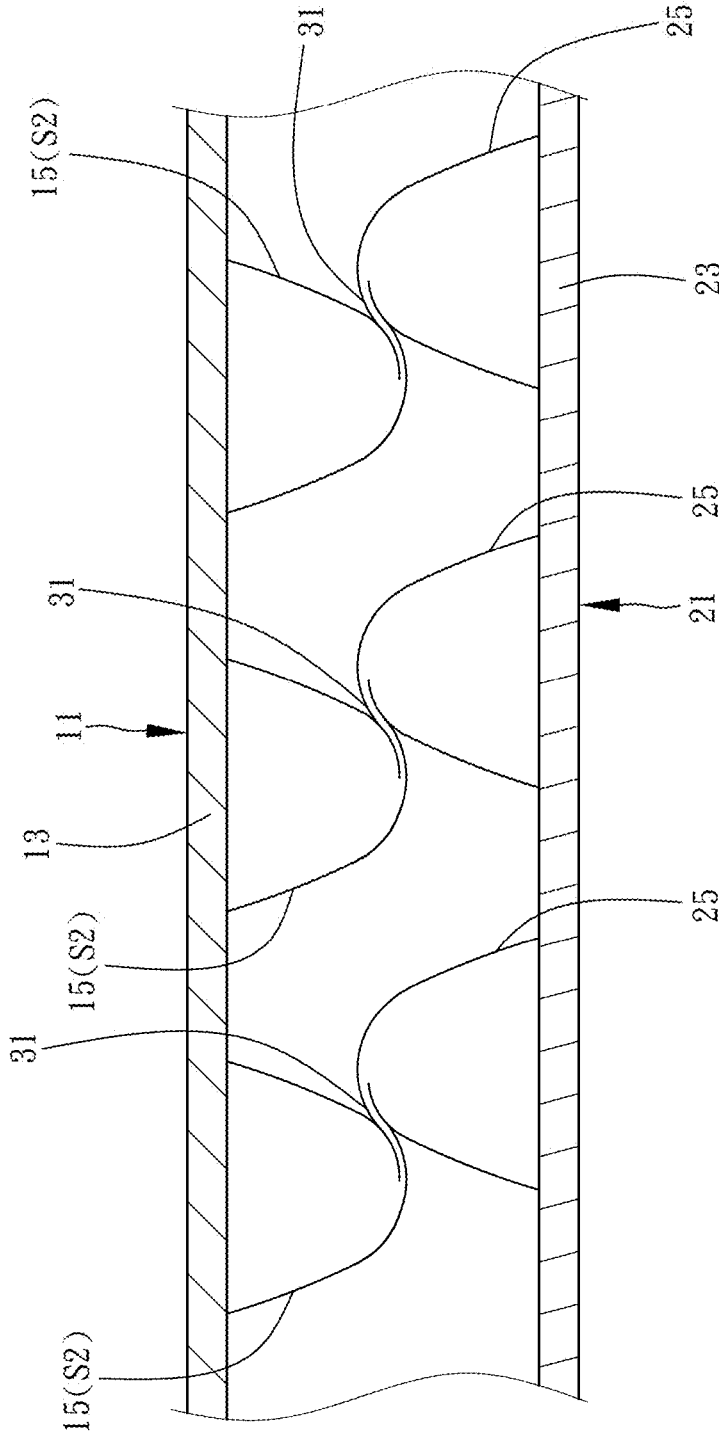


FIG. 3

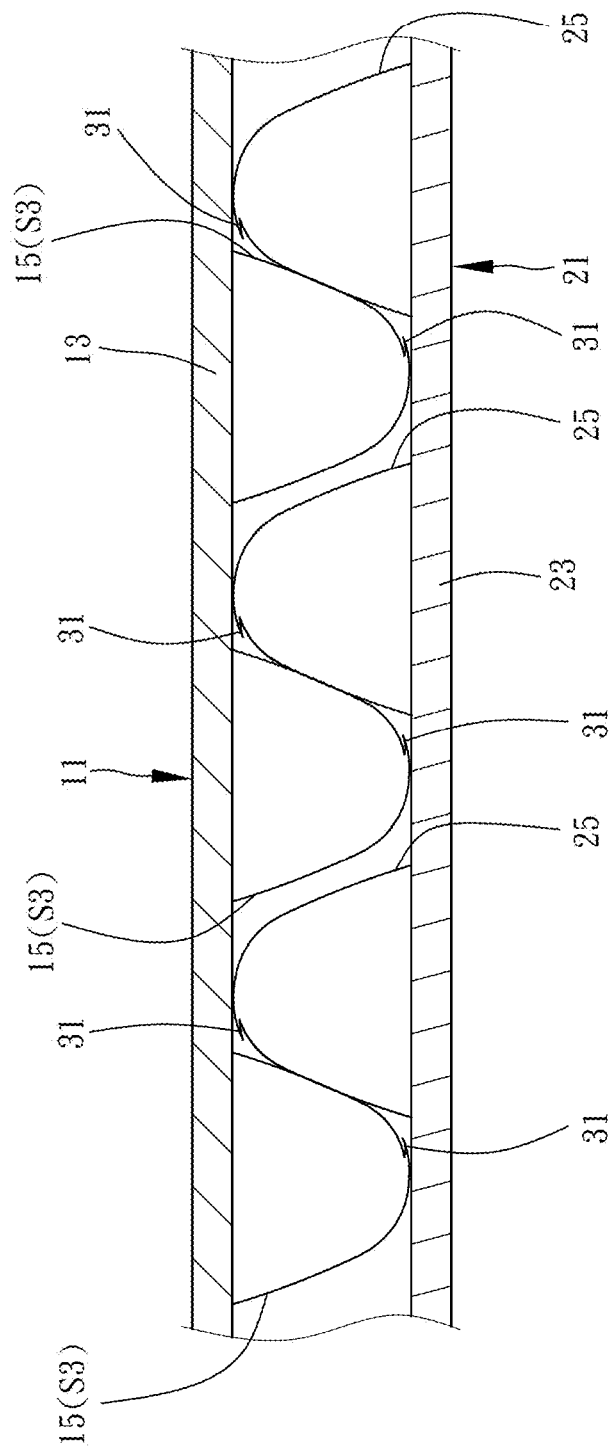


FIG. 4

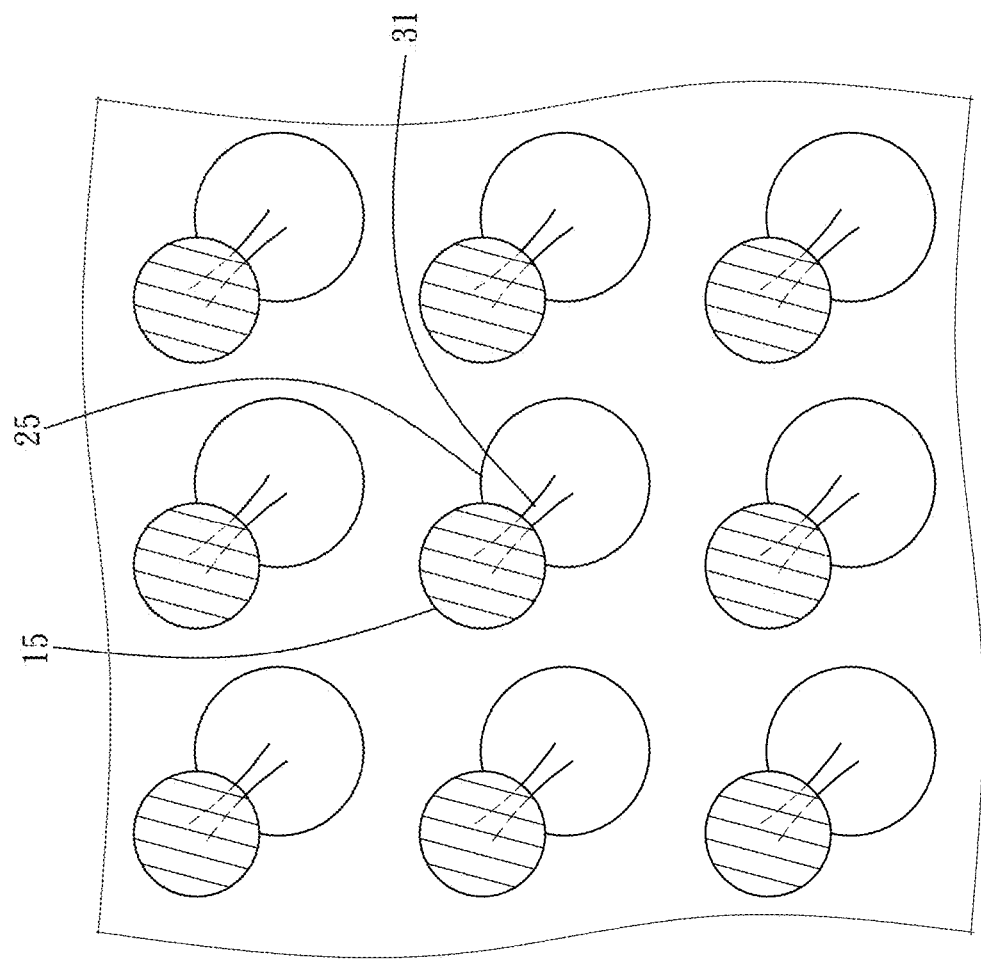


FIG. 5

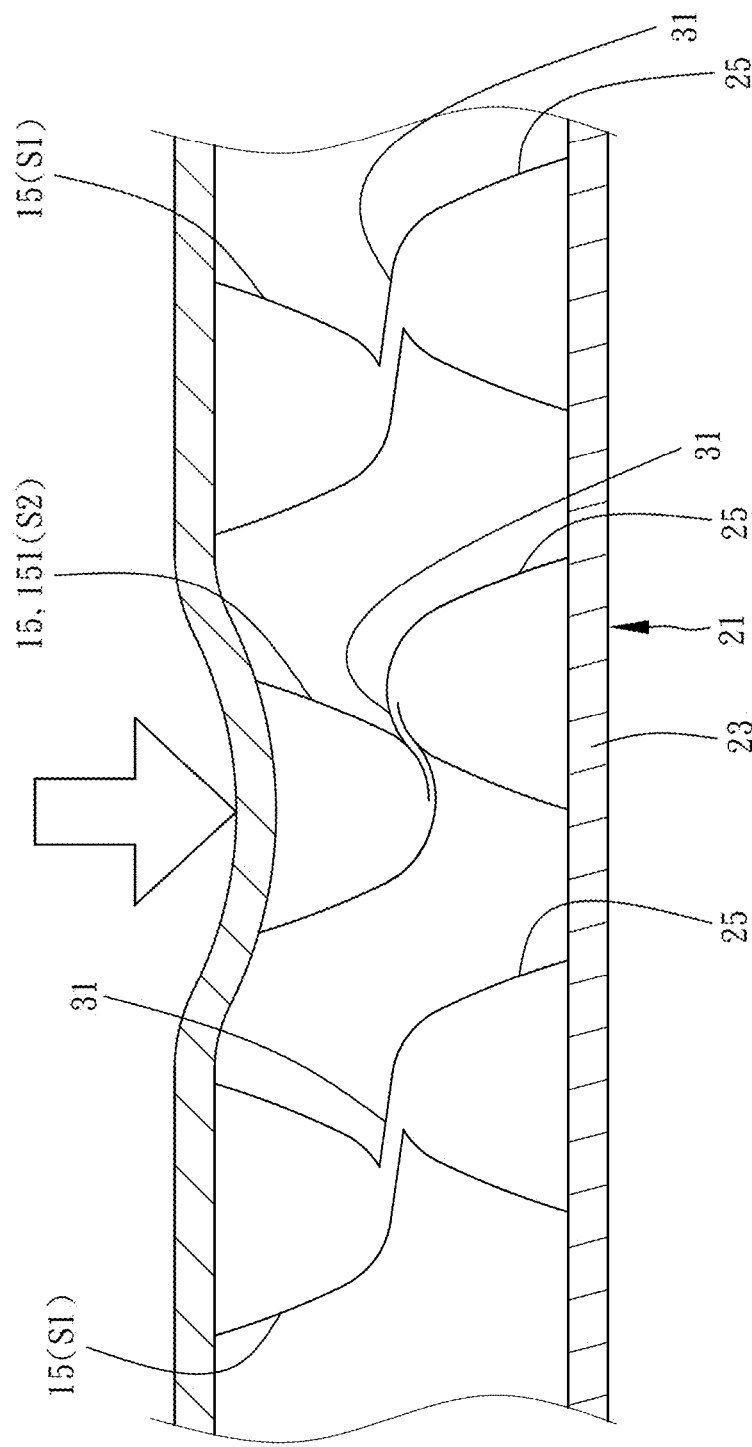
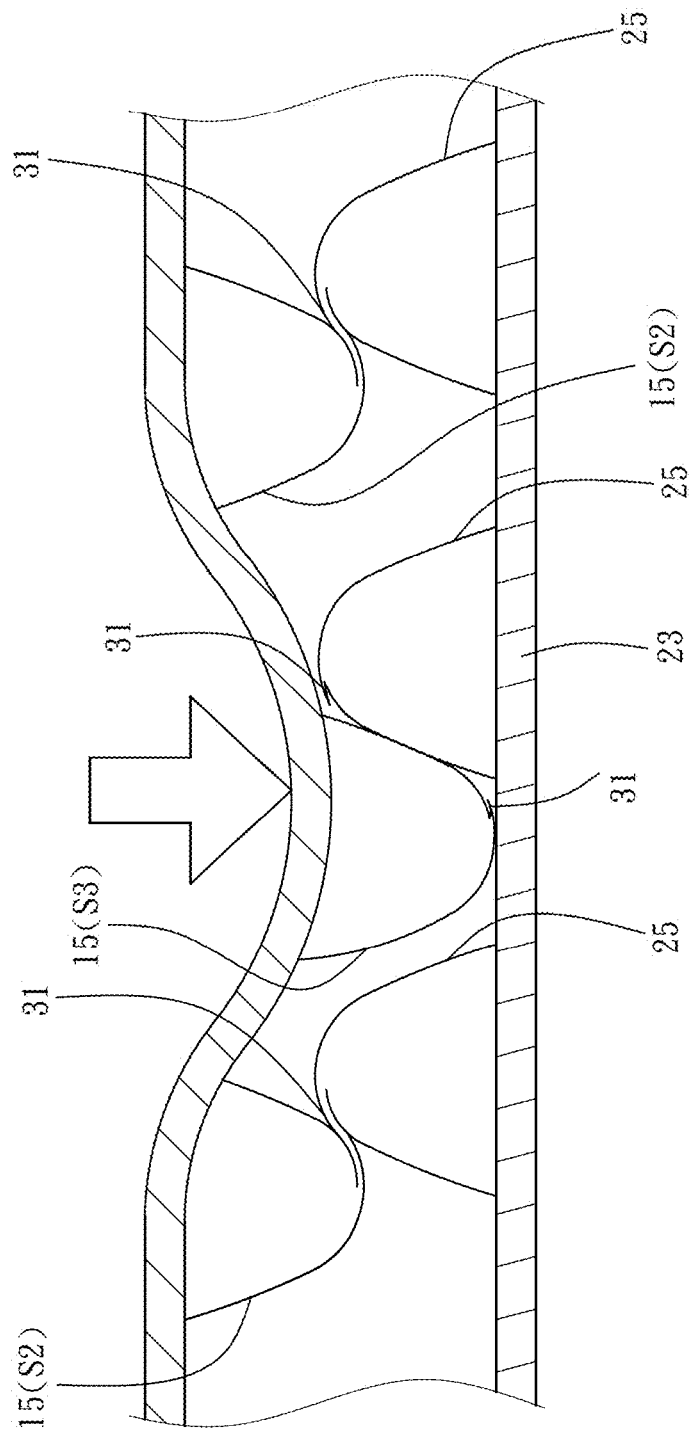


FIG. 6



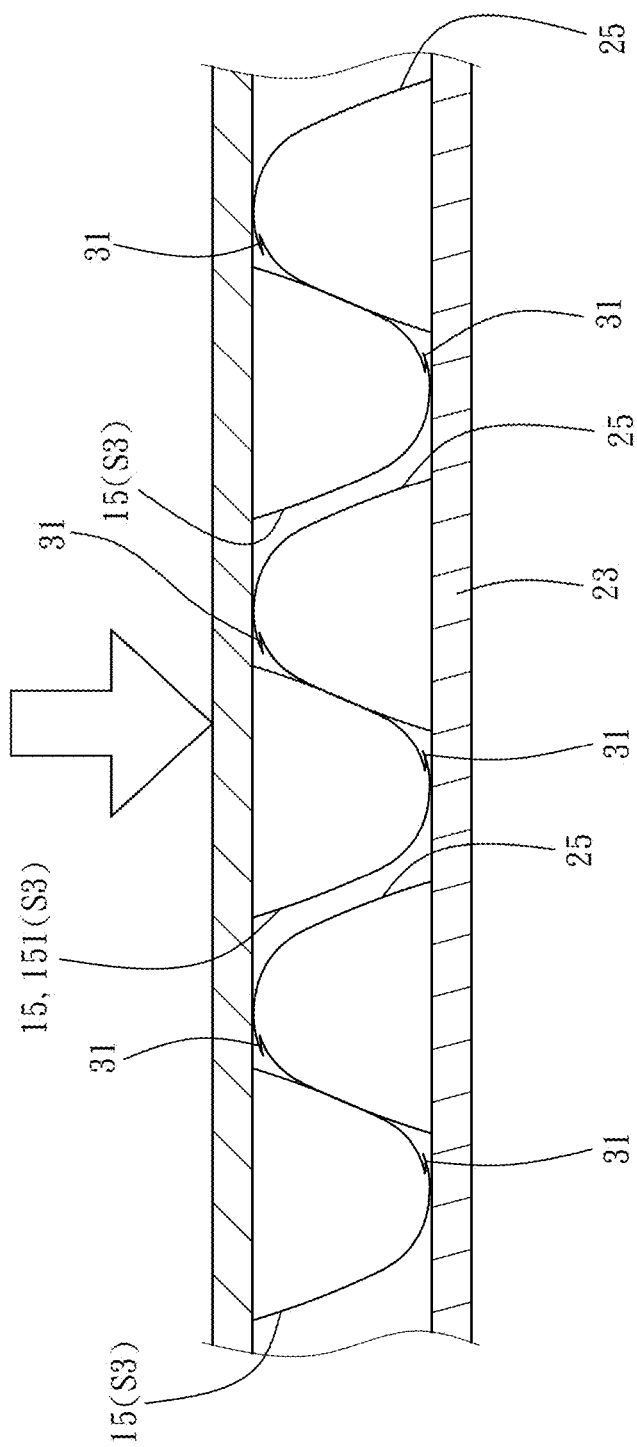


FIG. 8

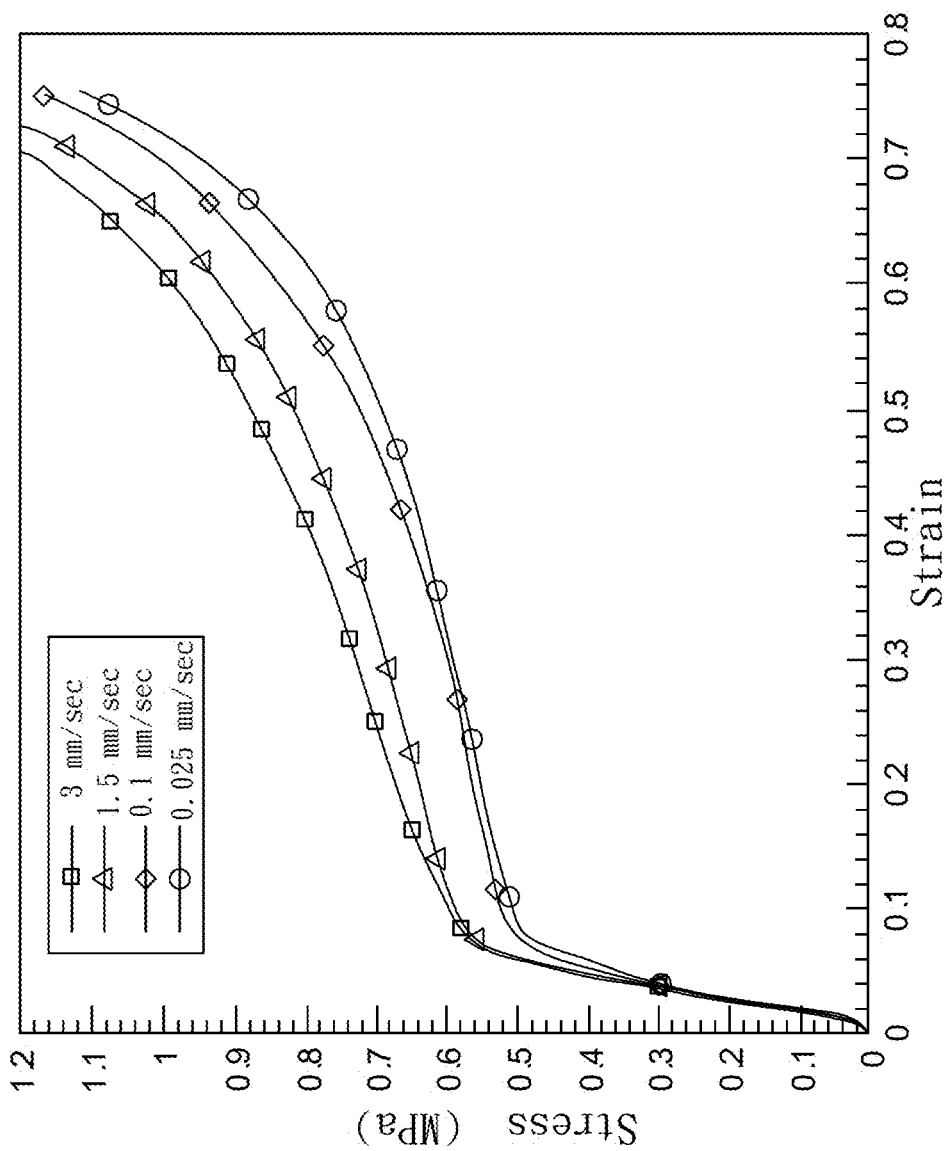


FIG. 9

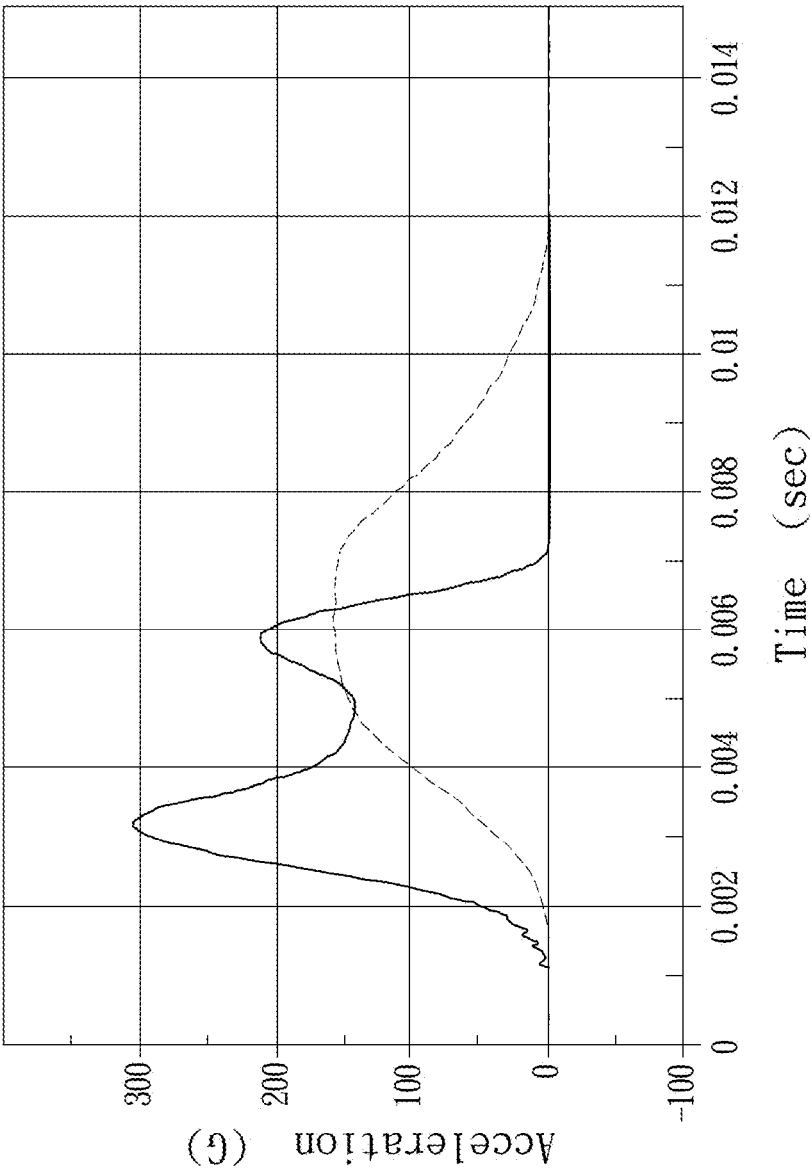


FIG. 10

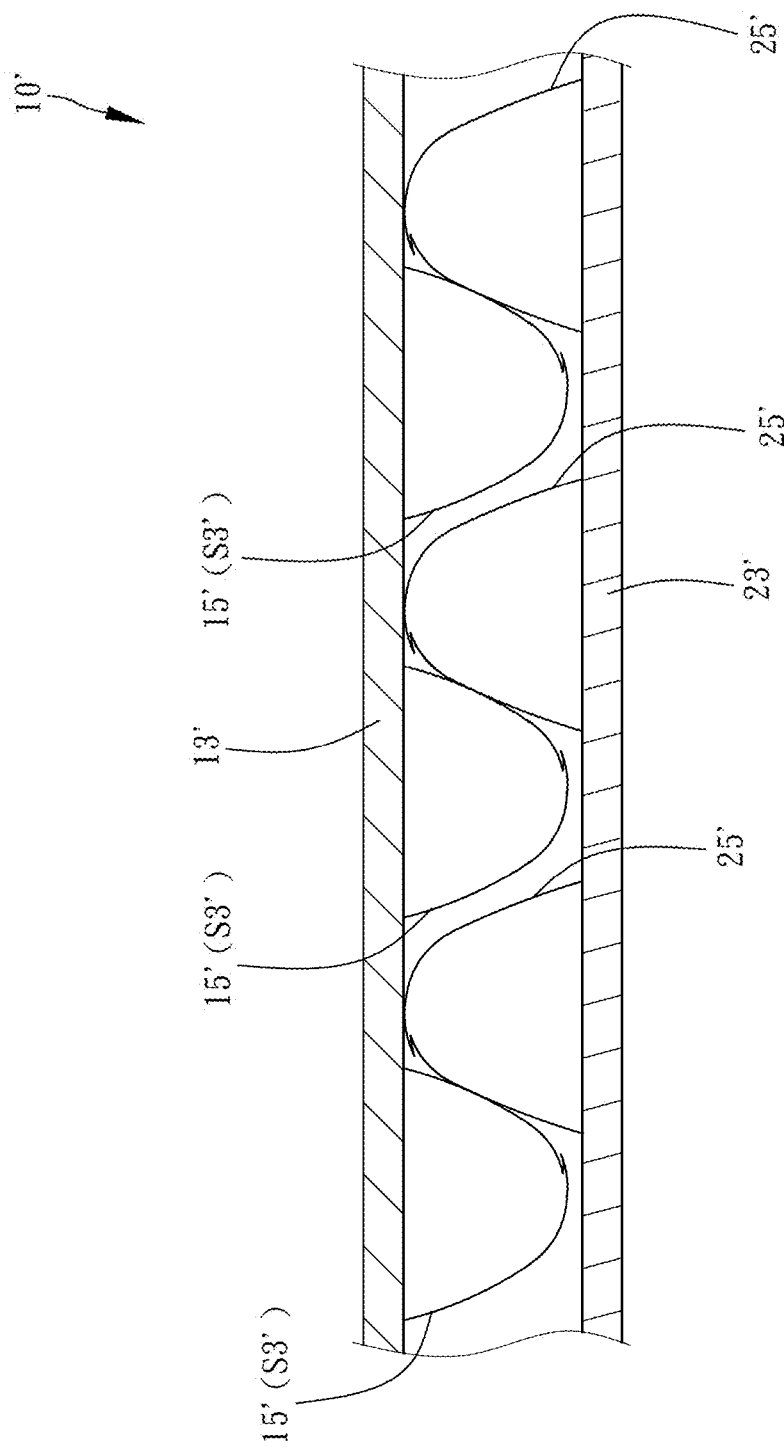


FIG. 11

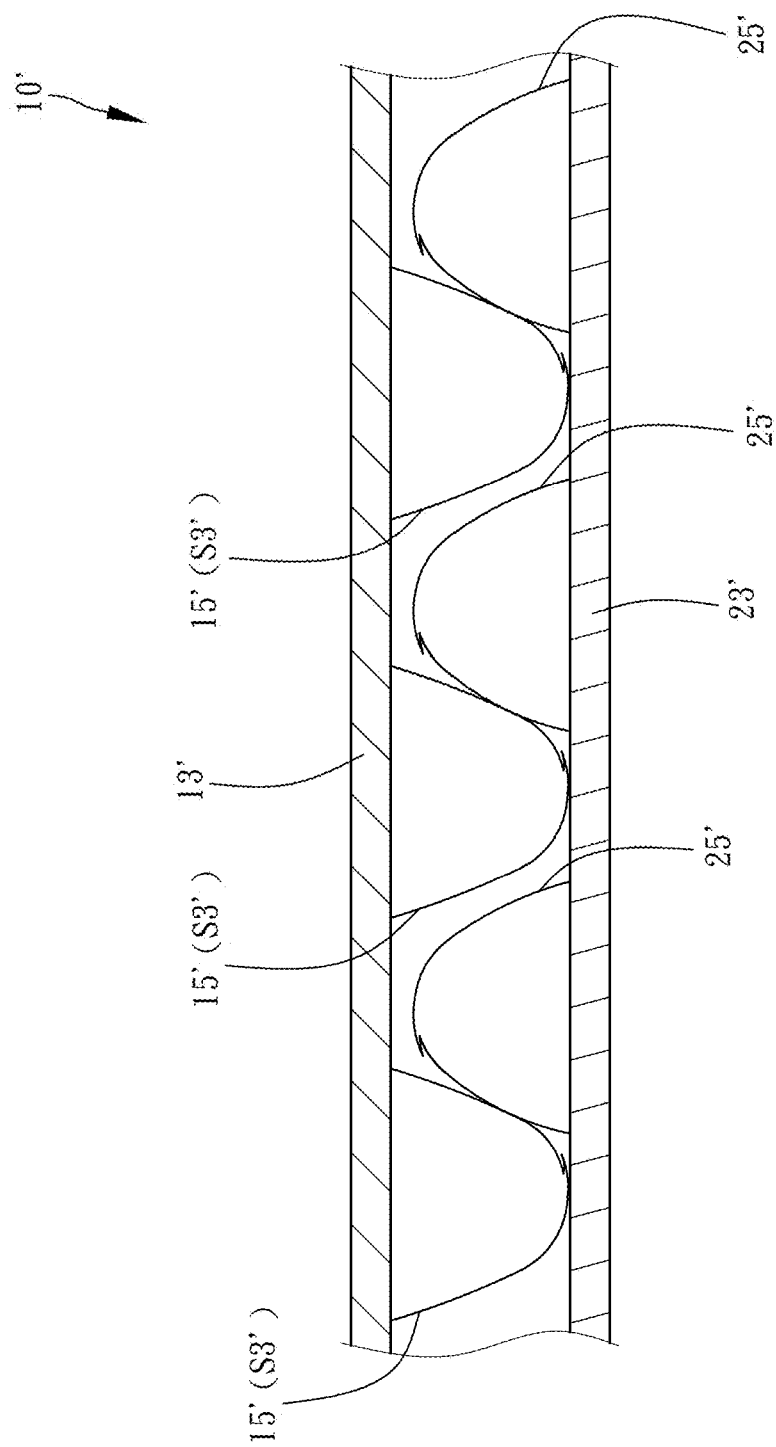


FIG. 12

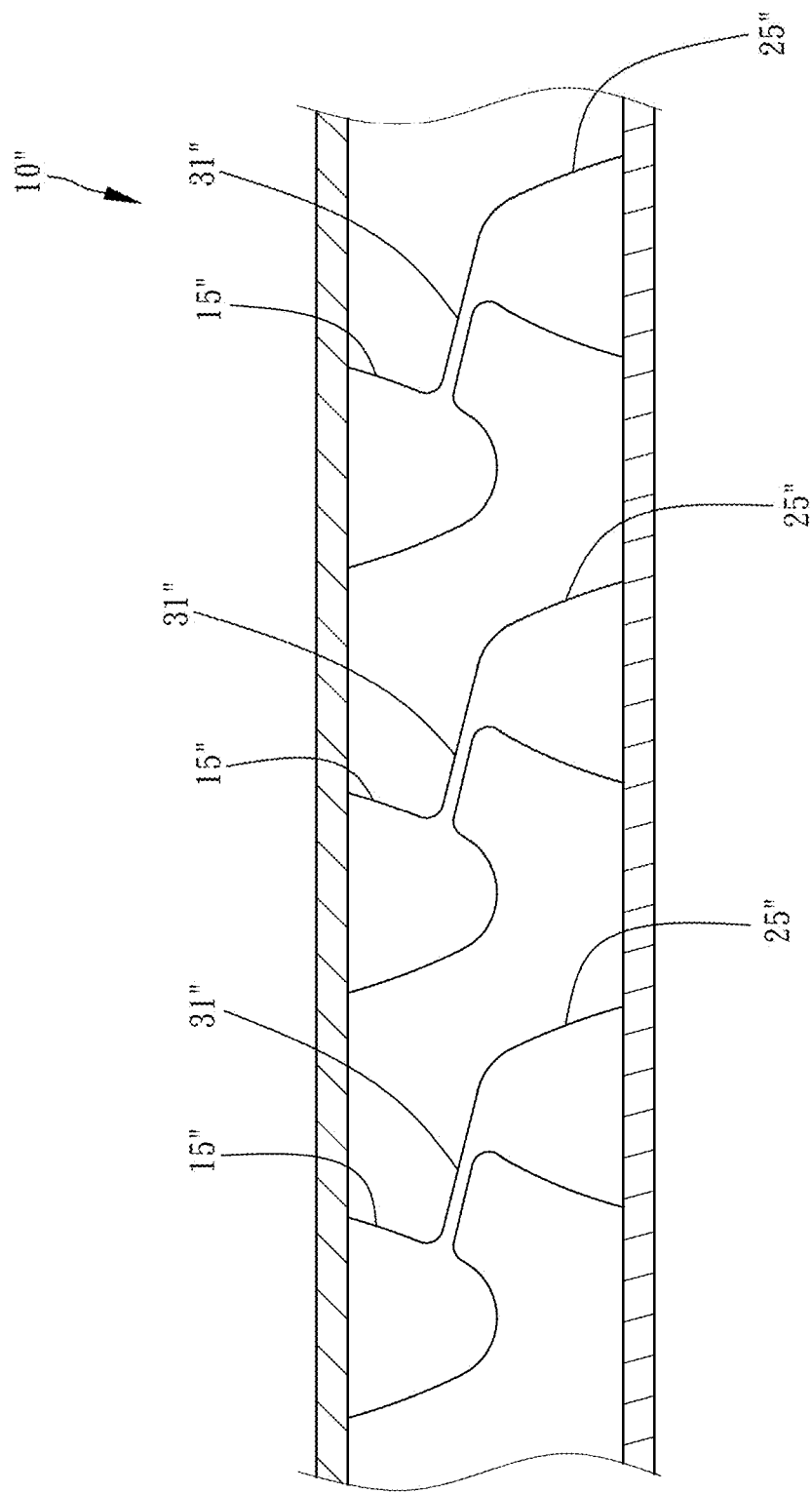


FIG. 13

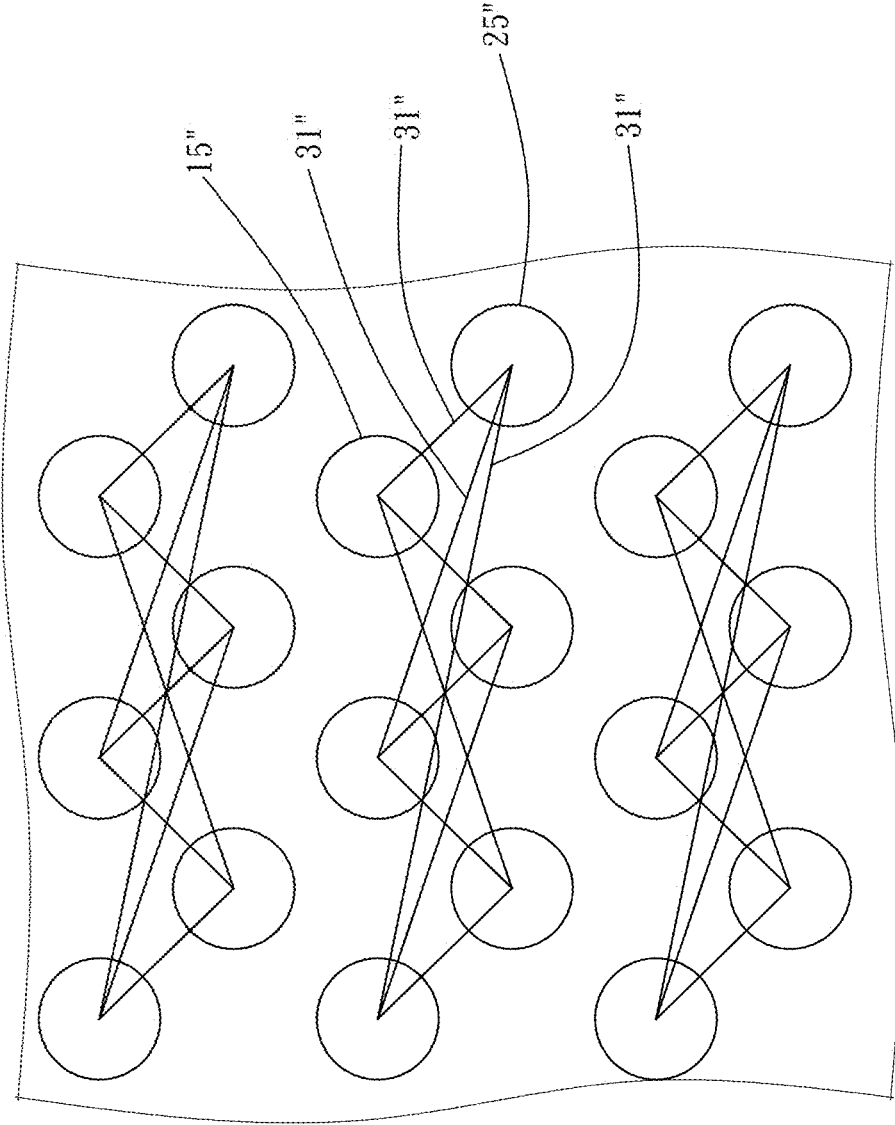


FIG. 14

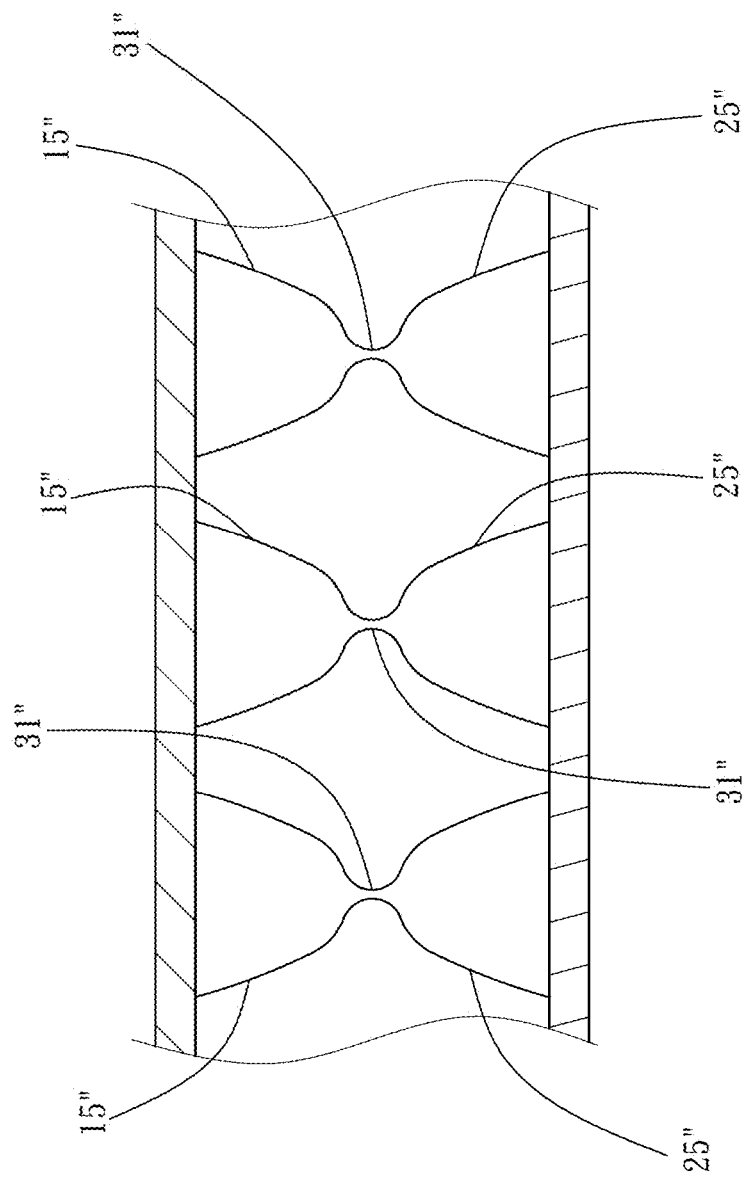


FIG. 15

HELMET LINER

BACKGROUND OF THE INVENTION

1. Technical Field

[0001] The present invention relates to helmets, and more particularly to a helmet liner.

2. Description of Related Art

[0002] A known helmet, as shown in FIG. 1, comprises a shell 100, a styrofoam liner 90 and a fabric layer 80. Such a helmet provides a human head with double protection in virtue of the shell 100 covering the helmet from outside and the styrofoam liner 90 padded inside the helmet.

[0003] As the first layer of protection provided by the conventional helmet, the shell 100 is hard and has a smooth surface, so that when a wearer gets impacted at his/her head, the hardness of the shell 100 reduces the impact force and the smooth surface of the shell 100 redirects the impact force form directly hitting the head of the wearer, thereby providing force-reducing effects.

[0004] The second layer of protection provided by the conventional helmet is attributable to the slight resilience of the styrofoam liner 90 that absorbs the vibration of the shell 100 caused by the impact and protects the head of the wearer from crush injury.

[0005] However, when the shell 100 receives an impact force that is greater than its protection capacity and consequently breaks or deforms, the impacting source will further compress the styrofoam liner 90. While the compressed styrofoam liner 90 can partially offset the impact force with its limited resilience, the surplus impact force will keep compressing the styrofoam liner 90 into a high-density, hard block, totally losing its impact-absorbing ability and leave the head of the wearer unprotected.

[0006] Hence, it is desirable to improve the impact-absorbing ability of the styrofoam liner, thereby ensuring safety of helmet wearers.

BRIEF SUMMARY OF THE INVENTION

[0007] The primary objective of the present invention is to provide a helmet liner, which has improved ability to absorb impact, thereby protecting helmet wearers with enhanced safety.

[0008] To achieve the foregoing objective, the disclosed a helmet liner comprises: an outer protective layer, being made of thermoplastic, the outer protective layer having a first base layer and a plurality of first bulges, the first bulges being provided on the first base layer and located at an inner side of the first base layer; an inner protective layer, being located at an inner side of the outer protective layer and separated from the outer protective layer by a predetermined distance, the inner protective layer being made of thermoplastic, the inner protective layer having a second base layer and a plurality of second bulges, the second bulges being provided on the second base layer and located at an outer side of the second base layer; and a plurality of breakable connecting members, being made of thermoplastic, the connecting members having a predetermined length, the predetermined length being smaller than the predetermined distance, and the connecting members being connected between the first bulges and the second bulges; wherein, when the outer protective layer receives an external inward

force that is smaller than a predetermined pressure, the first base layer deforms and drives the first bulges to move from a first position to a second position with the connecting members remaining intact, and when the external force is greater than the predetermined pressure, the connecting members break.

[0009] Thereby, the disclosed helmet liner provides reliable impact-absorbing capacity and ensures safety of helmet wearers.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0010] FIG. 1 is a cross-sectional view of a conventional helmet.

[0011] FIG. 2 is a side view of a first preferred embodiment of the present invention, showing that each of the first bulges and each of the second bulges have their site projections overlapping and the first bulges are at the first position with all the connecting members unbroken.

[0012] FIG. 3 is a side view similar to FIG. 2, showing that each of the first bulges is located at the second position with all the connecting members unbroken.

[0013] FIG. 4 is a side view similar to FIG. 2, showing that each of the first bulges is located at the third position with all the connecting members broken.

[0014] FIG. 5 is a cross-sectional view taken along Line 5-5 of FIG. 2.

[0015] FIG. 6 depicts a first aspect of the first preferred embodiment of the present invention, showing that central bulge is at the second position with the connecting member it connects not broken while the other first bulges are at the first position with the connecting members they connect not broken.

[0016] FIG. 7 depicts a second aspect of the first preferred embodiment of the present invention, showing that central bulge is at the third position with the connecting member it connects broken while the other first bulges are at the second position with the connecting members they connect not broken.

[0017] FIG. 8 depicts a third aspect of the first preferred embodiment of the present invention, showing that each of the first bulges is located at the third position and each of the connecting members has broken.

[0018] FIG. 9 is a graph of pressure testing results of the first preferred embodiment of the present invention.

[0019] FIG. 10 is a graph of impact testing results of the first preferred embodiment of the present invention.

[0020] FIG. 11 is a side view of a second preferred embodiment of the present invention, showing that the first bulges are at the third position where the first bulges are not abutting against the second base layer and the second bulge are abutting against the first base layer.

[0021] FIG. 12 is a side view of the second preferred embodiment of the present invention, showing that the first bulges are at the third position where the first bulges are abutting against the second base layer and the second bulges are not abutting against the first base layer.

[0022] FIG. 13 is a side view of a third preferred embodiment of the present invention, showing that the first and second bulges are not locationally overlapping and the connecting members are connected between the peripheries of the first bulges and the tops of the second bulges.

[0023] FIG. 14 is a schematic drawing of the third preferred embodiment of the present invention, showing that

the connecting members are connected between the first and second bulges in a one-to-many manner.

[0024] FIG. 15 is a side view of the third preferred embodiment of the present invention, showing that the first and second bulges are locationally coincide and the connecting members are connected to the tops of the first and second bulges.

DETAILED DESCRIPTION OF THE INVENTION

[0025] For further illustrating the means and functions by which the present invention achieves the certain objectives, the following description, in conjunction with the accompanying drawings FIGS. 2-10 and preferred embodiments, is set forth as below to illustrate the implement, structure, features and effects of the subject matter of the present invention.

[0026] As shown in FIG. 2, according to the first preferred embodiment of the present invention, a helmet liner 10 is padded in a helmet shell 100 (as shown in FIG. 1). Plural helmet liners 10 may be distributed across the inner side of the helmet shell 100 and work with the styrofoam liner 90 of a conventional helmet (as shown in FIG. 1). Alternatively, plural helmet liners 10 may be pieced together or a single helmet liner 10 may be used according to practical needs. In the first preferred embodiment, only one helmet liner 10 is used for an illustrative purpose. The helmet liner 10 is mainly composed of an outer protective layer 11, an inner protective layer 21, and a plurality of breakable connecting members 31.

[0027] The outer protective layer 11 is made of extendable thermoplastic, which is polystyrene foam in the present embodiment. The outer protective layer 11 has a first base layer 13 and a plurality of first bulges 15. The plural first bulges 15 are provided on the first base layer 13 located at the inner side of the first base layer 13.

[0028] The inner protective layer 21 is located at the inner side of the outer protective layer 11 and separated from the outer protective layer 11 by a predetermined distance. The inner protective layer 21 is made of extendable thermoplastic, which is polystyrene foam in the present embodiment. The inner protective layer 21 has a second base layer 23 and a plurality of second bulges 25. The plural second bulges 25 are provided on the second base layer 23 and located at the outer side of the second base layer 23.

[0029] The plural breakable connecting members 31 are made of extendable thermoplastic, which is polystyrene foam in the present embodiment. The plural connecting members 31 have a predetermined length are connected between the first bulges 15 and the second bulges 25. The predetermined length is smaller than the predetermined distance.

[0030] As shown in FIGS. 2-4 and FIG. 6, when the outer protective layer 11 receives an external inward force that is smaller than 1.1 Mpa (as indicated by the arrow in FIG. 6), the first base layer 13 deforms and drives the first bulges 15 to move from a first position S1 to a second position S2, and the connecting members 31 remain unbroken (as shown in FIG. 3). When the external force stops acting, the first bulges 15 return to their original places, namely moving from the second position S2 back to the first position S1 (returning from the state shown FIG. 2 back to the state shown in FIG. 1). Since the connecting members 31 are unbroken, the disclosed helmet liner 10 is still usable. When the external

force is greater than 1.1 Mpa, the first bulges 15 further move to a third position S3 and the connecting members 31 break (as shown in FIG. 4) so that the drawing force of the connecting members 31 between the first and second bulges 15, 25 provides the first reducing effect against the external force.

[0031] In practical use of the first preferred embodiment, the thermoplastic may alternatively be nylon (PA), polycarbonate (PC) or other thermoplastic materials. Therefore, all the thermoplastic materials being extendable after cured shall be included in the scope of the present invention, and the materials of the outer protective layer 11, the inner protective layer 21 and the connecting members 31 are not limited to what is recited for the first preferred embodiment. In addition, the impact-absorbing capacity of the connecting members 31 may vary depending on the thermoplastic material used, and therefore the threshold of the external force is not limited to 1.1 Mpa are recited for the first preferred embodiment.

[0032] In the first preferred embodiment, as shown in FIG. 2, in each of the first bulges 15 the width at its end near the first base layer 13 is greater than the width at its end far from the first base layer 13, and in each of the second bulges the width at its end near the second base layer 23 is greater than the width at its end far from the second base layer 23. With this configuration, the first and second bulges 15, 25 are unlikely to break, thereby enhancing the structural strength of the first and second bulges 15, 25.

[0033] In the first preferred embodiment, as shown in FIG. 2, each of the first bulges 15 and each of the second bulges 25 have their site projections overlapping. The plural connecting members 31 are connected between tops of the first and second bulges 15, 25.

[0034] In the first preferred embodiment, as shown in FIG. 4, when the first bulges 15 are located at third position S3, the first bulges 15 abut against the second base layer 23 and the second bulges 25 abut against the first base layer 13. The supporting force of the first and second bulges 15, 25 acting between the first base layer 13 and the second base layer 23 provides the second reducing effect against the external force.

[0035] In the first preferred embodiment, as shown in FIG. 5, the connecting members 31 are arranged unidirectionally and the connecting members 31 are connected to the first and second bulges 15, 25 in a one-to-one manner. The unidirectional state exists when the helmet liner 10 is laid flat and when the helmet liner 10 is not laid flat and crumples, the connecting members 31 may be posed in different directions.

[0036] With the technical features of the first preferred embodiment of the present invention as described previously, the first preferred embodiment of the present invention has different aspects.

[0037] As shown in FIGS. 6-8, generally, an external force acting on the liner is proliferated from the impact point to a surface. When the external force is greater than 1.1 Mpa, with the first bulge 15 moving earliest defined as a central bulge 151, the other first bulges 15 move in an outward sequence against the central bulge 151 from the first position S1 to the second position S2 and then to the third position S3. In the process where the first bulges 15 move from the first position S1 to the second position S2 and the connecting members 31 remain unbroken, the drawing force of the connecting members 31 between the first and second bulges 15, 25 provide the first reducing effect against the external

force first before the connecting members 31 break due to the external force. At this time, the first bulges 15 move to the third position S3 where the first bulges 15 abut against the second base layer 23 and the second bulges 25 abut against the first base layer 13. With the supporting force of the first and second bulges 15, 25 between the first base layer 13 and the second base layer 23, the external force is further reduced.

[0038] Reference is further made to FIGS. 2-4 and FIG. 9. According to FIG. 9 that shows the results of compression testing of the first preferred embodiment, the breaking point of the connecting members 31 varied with the compression rate. The predetermined pressure broke the connecting members 31 down to 1.1 Mpa. Now please refer to FIGS. 2-4 and 10. FIG. 10 shows the results of impact testing of a helmet shell padded with the helmet liner 10 of the first preferred embodiment of the present invention. Therein, the dotted line is associated with a conventional helmet using a styrofoam liner as described before with the maximum acceleration remaining 300G (G-Force) after impact, and the solid line is associated with a helmet using the disclosed helmet liner 10 instead of the prior-art styrofoam liner with the maximum acceleration being 150G after impact. This demonstrates that the present invention provides impact-absorbing capacity significantly better than that of the conventional helmet.

[0039] With the first bulges, second bulges and connecting members, the helmet liner of the present invention endows the helmet liner with reliable impact-absorbing capacity and ensures safety of helmet wearers.

[0040] The helmet liner 10' as provided in the second preferred embodiment of the present invention is similar to the first preferred embodiment except for the following technical features.

[0041] In the second preferred embodiment as shown in FIG. 11, when the first bulges 15' are located at the third position S3', the first bulges 15' are not abutting against the second base layer 23' and the second bulges 25' are abutting against the first base layer 13'. Alternatively, as shown in FIG. 12, when the first bulges 15' move to the third position S3', the first bulges 15' are abutting against the second base layer 23', and the second bulges 25' are not abutting against the first base layer 13'. Therefore, how it looks like when the first bulges 15' move to the third position S3' is not limited to that described in the first preferred embodiment.

[0042] The rest of the structure and effects of the second preferred embodiment are substantively similar to their counterparts in the first preferred embodiment and not redundantly described herein.

[0043] The helmet liner 10" as provided in the third preferred embodiment of the present invention is similar to the first preferred embodiment except for the following technical features.

[0044] The third preferred embodiment is depicted in FIGS. 13-15. As shown in FIG. 13, each of the first bulges 15" and each of the second bulges 25" are not locationally overlapping, and the connecting members 31" are connected between the peripheries of the first bulges 15" and the tops of the second bulges 25". As shown in FIG. 14, the connecting members 31" are connected between the first and second bulges 15", 25" in a one-to-many manner (for clearly expressing the connection, the connecting members 31" are indicated by lines), and the connecting members 31" are arranged in different directions. Alternatively, as shown in

FIG. 15, each of the first bulges 15" and each of the second bulge 25" may be locationally coincide and the connecting members 31" are connected between the tops of the first and second bulges 15", 25". Hence, the layout of the first and second bulges 15", 25", as well as how the connecting members 31" are connected between the first and second bulges 15", 25" and are arranged are not limited to those described in the first preferred embodiment.

[0045] The rest of the structure and effects of the third preferred embodiment are substantively similar to their counterparts in the first preferred embodiment and not redundantly described herein.

What is claimed is:

1. A helmet liner, comprising:

an outer protective layer, being made of thermoplastic, the outer protective layer having a first base layer and a plurality of first bulges, the first bulges being provided on the first base layer and located at an inner side of the first base layer;

an inner protective layer, being located at an inner side of the outer protective layer and separated from the outer protective layer by a predetermined distance, the inner protective layer being made of thermoplastic, the inner protective layer having a second base layer and a plurality of second bulges, the second bulges being provided on the second base layer and located at an outer side of the second base layer; and

a plurality of breakable connecting members, being made of thermoplastic, the connecting members having a predetermined length, the predetermined length being smaller than the predetermined distance, and the connecting members being connected between the first bulges and the second bulges;

wherein, when the outer protective layer receives an external inward force that is smaller than a predetermined pressure, the first base layer deforms and drives the first bulges to move from a first position to a second position with the connecting members remaining unbroken, and when the external force is greater than the predetermined pressure, the connecting members break.

2. The helmet liner of claim 1, wherein the predetermined pressure is 1.1 Mpa.

3. The helmet liner of claim 1, wherein each of the first bulges and each of the second bulges have their site projections overlapping each other.

4. The helmet liner of claim 1, wherein each of the first bulges and each of the second bulges have their site projections not overlapping each other.

5. The helmet liner of claim 1, wherein the connecting members are connected to tops of the first and second bulges.

6. The helmet liner of claim 1, wherein the connecting members are arranged unidirectionally.

7. The helmet liner of claim 1, wherein the connecting members are connected to the first and second bulges in a one-to-one or one-to-many manner.

8. The helmet liner of claim 1, wherein in each of the first bulges a width at its end near the first base layer is greater than a width at its end far from the first base layer, and in each of the second bulges a width at its end near the second base layer is greater than a width at its end far from the second base layer.

9. The helmet liner of claim 1, wherein the first bulges move from the first position to the second position in a manner that with the first bulge moving the earliest defined as a central bulge, the other first bulges move from the first position to the second position in an inside-out sequence against the central bulge.

10. The helmet liner of claim 1, wherein when the external force is greater than the predetermined pressure, the first bulges moves from the second position to a third position, so that the first bulges abut against the second base layer and the second bulges abut against the first base layer.

11. The helmet liner of claim 1, wherein when the external force is greater than the predetermined pressure, the first bulges moves from the second position to a third position, so that the first bulges do not abut against the second base layer and the second bulges abut against the first base layer.

12. The helmet liner of claim 1, wherein when the external force is greater than the predetermined pressure, the first bulges moves from the second position to a third position, so that the first bulges abut against the second base layer and the second bulges do not abut against the first base layer.

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