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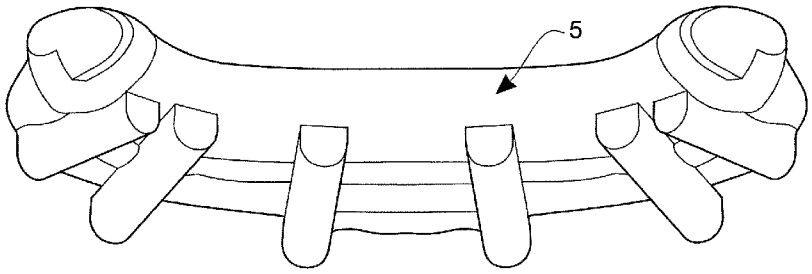


FIG 9

(57) Abstract: A pedestrian airbag arrangement on a motor vehicle (20) having a windscreen (21) is disclosed. The arrangement comprises an airbag (1) having an inflatable volume for the receipt of inflating gas, and is characterised in that said inflatable volume of the airbag (1) comprises a primary chamber (5) configured for inflation upon deployment of the airbag so as to extend over or across at least part of the windscreen (21); and a plurality of secondary chambers (18), each said secondary chamber (18) being configured for inflation upon deployment of the airbag so as to adopt a respective deployed position between the primary chamber (5) and the windscreen (21), to thereby space the primary chamber (5) from the windscreen (21).

A PEDESTRIAN AIRBAG ARRANGEMENT

The present invention relates to a pedestrian airbag arrangement, and more particularly relates to a pedestrian airbag arrangement on a motor vehicle having a windscreen.

When a motor vehicle is involved in a frontal impact with a pedestrian, it is common for the body of the pedestrian to strike the windscreen of the vehicle which can result in serious injury to the pedestrian, and significant damage to the vehicle. In an attempt to alleviate this, it has been proposed to provide a motor vehicle with a so-called pedestrian airbag which, if vehicle sensors indicate that a collision with a pedestrian is occurring or is likely to occur, inflates to cover a central portion of the windscreen, and/or the left and right A-pillars of the vehicle. Typically, an airbag of this general type is provided in an initially tightly folded and/or rolled package and is stored beneath a rear part of the vehicle's hood or bonnet, or beneath a cowl which is provided between the base of the windscreen and the rear part of the hood or bonnet. The rear of the hood or bonnet may be lifted by a suitable air-bag, piston or other arrangement to allow sufficient space for the pedestrian airbag to inflate so that it deploys in a manner effective to cover at least part of the windscreen and/or A-pillars of the vehicle, thereby cushioning the impact of a pedestrian with these parts of the vehicle. Alternatively, it is also possible to configure the pedestrian airbag such that as it begins inflation it performs the hood-lifting function itself. Such an arrangement may incorporate a cell structure to the pedestrian airbag beneath the hood, or may comprise a structure adjacent the airbag to guide the airbag for inflation in a direction effective to lift the rear part of the hood or bonnet.

As will be appreciated, however, space beneath the rear part of a vehicle's hood or bonnet can be very limited which makes it difficult to conveniently package a sufficiently large airbag to ensure adequate protection for a pedestrian. Also, the larger the airbag which is successfully packaged in such an arrangement, then the larger the volume of gas required to inflate the airbag (which also necessitates a larger inflator). Relying on a large volume of gas to inflate a pedestrian airbag generally results in a slower deployment time which can adversely affect the effectiveness of the airbag in preventing or reducing injuries to a pedestrian.

It is a preferred object of the present invention to provide an improved pedestrian airbag arrangement.

According to the present invention, there is provided a pedestrian airbag arrangement on a motor vehicle having a windscreen, the arrangement comprising an airbag having an inflatable volume for the receipt of inflating gas, and being characterised in that said inflatable volume of the airbag comprises a primary chamber configured for inflation upon deployment of the airbag so as to extend over or across at least part of the windscreen; and a plurality of secondary chambers, each said secondary chamber being configured for inflation upon deployment of the airbag so as to adopt a respective deployed position between the primary chamber and the windscreen, to thereby space the primary chamber from the windscreen.

Preferably, the respective deployed positions of said secondary chambers are spaced apart from one another.

Advantageously, the deployed positions of the secondary chambers are spaced apart from one another in a transverse direction across the vehicle.

Conveniently, said primary chamber and each said secondary chamber are formed from flexible material, and wherein the material forming each said secondary chamber is connected to the material forming the primary chamber.

Preferably, said flexible material is fabric and the fabric forming each said secondary chamber is stitched to the fabric forming the primary chamber.

Advantageously, said secondary chambers are formed integrally with the primary chamber.

Conveniently, the airbag is formed from fabric material, and the secondary chambers and the primary chamber are formed integrally via a one-piece weaving technique.

Preferably, part of each secondary chamber is defined by a respective region of flexible material defining the primary chamber.

Advantageously, each said secondary chamber is provided in fluid communication with said primary chamber.

Preferably, said fluid communication is provided by at least one aperture formed in the primary chamber.

Conveniently, the arrangement further comprises an inflator arranged to direct a volume of inflating gas into said primary chamber upon actuation, wherein each said secondary chamber is arranged for inflation via a flow of said inflating gas from said primary chamber.

Preferably, the inflatable volume of each said secondary chamber is smaller than the inflatable volume of said primary chamber.

Advantageously, the total inflatable volume of said secondary chambers is smaller than the inflatable volume of said primary chamber.

Conveniently, said primary chamber and each said secondary chamber have a substantially elongate configuration when inflated, and wherein the deployed position of each said secondary chamber is generally orthogonal to the inflated position of the primary chamber.

Preferably, said primary chamber has a generally elongate and arcuate configuration when inflated, and each secondary chamber has a substantially elongate configuration when inflated, the deployed positions of the secondary chambers each being generally orthogonal to the respective adjacent regions of the primary chamber.

Advantageously, each said secondary chamber is connected along substantially its entire length to the primary chamber.

Conveniently, each said secondary chamber has an inflated configuration in which it presents a curved outer surface towards the windscreen of the vehicle.

Preferably, said primary chamber is sub-divided into a plurality of inflatable cells in fluid communication with one another, and each said secondary chamber is provided in fluid communication with at least one of said cells.

So that the invention may be more readily understood, and so that further features thereof may be appreciated, embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a plan view showing an initial stage in the production of a pedestrian airbag embodying the present invention, illustrating two superimposed sheets of flexible material;

Figure 2 is a view corresponding generally to that of figure 1, showing the sheets connected around their peripheral edges to define a primary inflatable chamber;

Figure 3 is a plan view showing further pieces of flexible material used in the construction of the airbag;

Figure 4 is a perspective view showing the pieces of fabric illustrated in figure 3 connected together to form another part of the airbag;

Figure 5 is a perspective view showing a number of parts of the type illustrated in figure 4 connected to the primary inflatable chamber illustrated in figure 2, so as to define respective secondary inflatable chambers of the airbag;

Figure 6 is a perspective view showing the airbag of figure 5 in a deployed position across the windscreen of a motor vehicle;

Figure 7 is a cross-sectional view taken along line VII-VII in figure 6, showing the cross-sectional configuration of the inflated airbag relative to the windscreen of the vehicle;

Figure 8 is a perspective view similar to that of figure 5, but which shows an alternative configuration of airbag embodying the present invention;

Figure 9 is a perspective view of the airbag illustrated in figure 8, showing the airbag as viewed from the rear and below; and

Figure 10 is a cross-sectional view taken along line X-X in figure 8, showing the cross-sectional configuration of the airbag.

Referring initially to figures 1 to 5, the construction and resulting configuration of a simple form of pedestrian airbag in accordance with the invention will be described.

Figure 1 shows a pair substantially identical sheets 2, 3 of flexible material from which the pedestrian airbag 1 is produced. The sheets 2, 3 are preferably formed from woven fabric material and in the embodiment illustrated are both generally rectangular. The sheets 2, 3 are shown in figure 1 in superimposed relation to one another. As shown in figure 2, the two sheets 2, 3 are interconnected along substantially the entire extent of their peripheral edges by a peripheral seam 4 to define a primary inflatable chamber 5 between the sheets for the receipt of inflating gas. The primary chamber 5 is elongate and generally rectangular.

As will be noted, each sheet 2, 3 is provided with an outwardly projecting tab 6 at a generally central position along one of its long sides. The two tabs 6 are aligned when the sheets are

superimposed, and the peripheral seam 4 connecting the two sheets begins at one end of the aligned tabs 6, runs around the periphery of the rectangular sheets, and terminates at the opposite end of the aligned tabs 6. The tabs 6 are thus unconnected along their length and so cooperate to form a neck 7 to the airbag, the neck defining a gas inlet aperture 8 to the airbag. The neck 7 is intended to be fitted to an inflator such as a gas generator in a known manner, such that upon actuation of the inflator, a large volume of inflating gas will be directed into the interior volume of the primary inflatable chamber 5, thereby inflating the airbag 1.

It is to be noted, however, that the lower of the two fabric sheets 3 illustrated in figures 1 and 2 is provided with a plurality of apertures 9. The apertures 9 are spaced-apart from one another along the length of the sheet 3, and each defines a respective gas flow port, the purpose of which will be described in more detail below.

Turning now to consider figure 3, there are shown three pieces of flexible material 10,1 1,12 which are used to form a secondary inflatable chamber to the airbag 1. In preferred embodiments the three pieces 10,1 1,12 are formed of the same type of woven fabric as the two sheets 2, 3 used to define the primary chamber 5 of the airbag. As will be noted, two of the pieces of fabric 10,1 1 are generally n- or u-shaped and thus each has a relatively short straight edge 13 and a relatively long arcuate edge 14. The other piece of fabric 12 is generally rectangular in shape and thus has a pair of relatively short edges 15 and a pair of relatively long edges 16. The short edges 15 of the rectangular fabric piece 12 are approximately equal in length to the arcuate edges 14 of the other two fabric pieces 10,1 1.

As illustrated in figure 4, each short edge 15 of the rectangular fabric piece 12 is connected along its length to a respective arcuate edge 14 of the other pieces 10,1 1 to form an elongate open-topped channel 17 which is closed at each end by a respective one of the smaller fabric pieces 10,1 1. By virtue of the interconnection of each arcuate edge 14 of the smaller fabric pieces 10,1 1 with the short edges 15 of the rectangular piece, the undersurface of the channel 17 is arcuate.

In the embodiment illustrated in figures 1 to 7 of the drawings, four generally identical open-topped fabric channels 17 are formed in the manner described above.

Turning now to consider figure 5, the primary inflatable chamber 5 of figure 2 is shown in perspective view. As illustrated, the four open-topped channels 17 are arranged beneath the

primary chamber 5 in spaced-apart and generally parallel relationship to one another. More particularly, it will be noted that the channels are spaced apart along the length of the primary chamber 5, with each channel 17 being positioned against the rear sheet 3 of the primary chamber so as to cover a respective aperture 9 formed through the rear sheet 3. The long edges 16 and the short edges 13 each channel 17 are then connected to the rear sheet 3, for example via stitching.

It is therefore to be appreciated that when each channel 17 is connected to the rear sheet 3 of the primary chamber 5 as described above and as shown in figure 5, the channels 17 cooperate with respective regions of the rear sheet 3 to define respective secondary chambers 18. The apertures 9 formed in the rear sheet 3 each define flow ports between the primary chamber 5 and the secondary chambers 18, and thus provide fluid communication between the inflatable volume of primary chamber 5 and the secondary chambers 18.

The airbag 1 is initially provided in a tightly packed package (not shown) under a rear part of the hood or bonnet 19 of a motor vehicle 20, at a position immediately in front of the vehicle's windscreen 21. More particularly, the airbag 1 will be fluidly connected, via its neck 7 and associated inlet aperture 8, to an inflator 22 such as a gas generator mounted beneath the rear part of the hood or bonnet 8.

Figures 6 and 7 illustrate a motor vehicle 20 fitted with a pedestrian airbag 1 in accordance with the embodiment described above, and show the airbag 1 in an inflated condition following actuation of the inflator 22. The rear of the hood or bonnet 19 is lifted, for example by another air-bag, a piston or other lifting arrangement, to allow sufficient space for the pedestrian airbag 1 to inflate so that it deploys in a manner effective to cover at least part of the windscreen 21 and the adjacent A-pillars 23 of the vehicle, thereby cushioning the impact of a pedestrian with these parts of the vehicle.

More particularly, having regard to figure 7, it should be noted that upon initial actuation of the inflator 22, a large volume of inflating gas is directed at high speed through the neck 7 and into the primary chamber 5 defined between the main front and rear fabric sheets 2, 3 of the airbag, as illustrated schematically by arrow 24. This flow of gas serves to rapidly inflate the primary chamber 5 of the airbag 1, thereby ensuring that the airbag 1 deploys quickly from its initial packed configuration so as to extend generally across the windscreen 21 of the vehicle 20, as illustrated in figure 6.

As the primary chamber 5 reaches substantially complete inflation, secondary flows of the inflating gas occur through the flow ports 9 in the rear sheet 3 of the primary chamber 5, and thus into the secondary chambers 18 as illustrated schematically by arrow 25, thereby inflating the secondary chambers 18 such that they adopt their elongate inflated configurations as illustrated in figures 5-7.

As shown particularly in figure 6, in their inflated and deployed positions, the secondary chambers 18 are spaced apart from one another in a transverse direction across the vehicle. More particularly, it will be noted that the deployed positions of the secondary chambers 18 are generally parallel to one another and orthogonal to the length of the primary chamber 5.

Furthermore, as shown in figure 7, the secondary chambers 18 inflate so as to adopt deployed positions between the primary chamber 5 of the airbag 1 and the windscreen 21 of the vehicle, and thus serve to space the rear sheet 3 of the primary chamber 5 from the windscreen, creating cavities 26 between the primary chamber 5 and the windscreen, each cavity 26 being formed between adjacent secondary chambers 18. The curved lower surface of each secondary chamber 18 is arranged to bear against the windscreen or the adjacent structure of the vehicle. Each secondary chamber 18 can be considered to represent a "fender" in its inflated configuration, effective to space the primary chamber 5 from the windscreen, thereby improving the cushioning properties of the primary chamber.

It has been found that the above-mentioned inflation characteristic in which the primary chamber 5 of the airbag is spaced from the windscreen 21 of the vehicle by the cavities 26 between adjacent secondary chambers 18, significantly improves the protection afforded to the head of a pedestrian striking the airbag 1. It is thought that this improvement in the level of protection results from the increase in distance through which energy can be absorbed by the airbag 1 for a given total inflatable volume of the entire airbag. The provision of the secondary chambers 18, which inflate upon deployment of the airbag to form "fenders" spacing the larger primary chamber 5 of the airbag from the windscreen 21, allows the total inflatable volume of the entire airbag 1 to be reduced compared to prior art arrangements without any reduction in the level of impact protection provided to the head or torso of a pedestrian impacting the bag.

Whilst the invention has been described above with reference to a specific embodiment, it is to be appreciated that various modifications or alterations could be made to the airbag arrangement without departing from the scope of the claimed invention. For example,

although the embodiment illustrated in figures 1 to 7 has been described above as comprising secondary chambers 18 which are formed from separate pieces of fabric 10, 11, 12 which are stitched together and then also stitched to the rear sheet 3 of the primary chamber 5, it is envisaged that in variants of the invention the secondary chambers 18 could each be formed integrally with the primary chamber 5. For example, it is proposed that the primary and secondary chambers could be woven simultaneously via a so-called "one-piece weaving" technique of a type known *perse.* In such an arrangement it is envisaged that the fabric pieces defining the secondary chambers 18 would be woven simultaneously with the fabric sheets defining the primary chamber 5, with the warp and weft yarns forming the pieces and sheets being interwoven in selected areas to form integral interconnecting seams between the secondary chambers 18 and the primary chamber 5.

Figures 8 to 10 illustrate schematically airbag embodiment in accordance with the present invention, which in many respects is similar to the simple arrangement described above and illustrated in figures 1 to 7. A principle difference between the arrangement of figures 8 to 10 and the arrangement of figures 1 to 7 is that the arrangement shown in figures 8 to 10 has a more intricately shaped primary chamber 5. In particular, it will be noted that the primary chamber 5 has a generally arcuate configuration as viewed from above in figure 8. Furthermore, it will be noted that there are a total of six secondary chambers 18 provided in this modified embodiment, with the secondary chambers 18 no longer being parallel to one another in their elongate and inflated configuration as illustrated. More particularly, the secondary chambers 18 are arranged relative to one another in their inflated positions such that they converge towards the transverse axis 27 of the airbag 1 (which will be generally coincident with the longitudinal axis of the vehicle upon deployment) in a rearward direction away from the inflator 22 (which in this arrangement is proposed to be provided inside the primary chamber 5. Nevertheless, because of the arcuate configuration of the primary chamber 5, each secondary chamber 18 is still generally orthogonal to the respective part of the elongate primary chamber 5 to which it is attached or formed.

The other main difference between the arrangement of figures 8 to 10 and the arrangement of figures 1 to 7, is that in the arrangement of figures 8 to 10 the primary chamber 5 is sub-divided into a plurality of inflatable cells as illustrated most clearly in the sectional view of figure 10. In the particular arrangement illustrated, the primary chamber 5 is sub-divided into two such cells, namely a forwardly positioned cell 28 and a rearwardly positioned cell 29. The two cells are each generally elongate and either connected to one another or formed

integrally with one another (for example via a "one-piece weaving" technique) such that both will extend generally transversely across the windscreen of a motor vehicle upon deployment. The two cells 28, 29 are provided in fluid communication with one another, for example via a narrow flow passage 30 which can extend along a significant length of the primary chamber. As will be noted, in this arrangement, the secondary chambers 18 are each provided in fluid communication with the primary chamber 5 via respective flow ports 9 in the undersurface of the rearward inflatable cell 29.

In other respects, the modified arrangement of figures 8 to 10 will operate in a similar manner to the arrangement of figures 1 to 7, particularly as regards inflation of the secondary chambers 18 so as to adopt respective deployed positions between the primary chamber and the windscreen of a motor vehicle, to thereby space the primary chamber from the windscreen.

When used in this specification and claims, the terms "comprises" and "comprising" and variations thereof mean that the specified features, steps or integers are included. The terms are not to be interpreted to exclude the presence of other features, steps or integers.

The features disclosed in the foregoing description, or in the following claims, or in the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for obtaining the disclosed results, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

While the invention has been described in conjunction with the exemplary embodiments described above, many equivalent modifications and variations will be apparent to those skilled in the art when given this disclosure. Accordingly, the exemplary embodiments of the invention set forth above are considered to be illustrative and not limiting. Various changes to the described embodiments may be made without departing from the spirit and scope of the invention.

CLAIMS

1. A pedestrian airbag arrangement on a motor vehicle (20) having a windscreen (21), the arrangement comprising an airbag (1) having an inflatable volume for the receipt of inflating gas, and being characterised in that said inflatable volume of the airbag (1) comprises a primary chamber (5) configured for inflation upon deployment of the airbag so as to extend over or across at least part of the windscreen (21); and a plurality of secondary chambers (18), each said secondary chamber (18) being configured for inflation upon deployment of the airbag so as to adopt a respective deployed position between the primary chamber (5) and the windscreen (21), to thereby space the primary chamber (5) from the windscreen (21).

2. A pedestrian airbag arrangement according to claim 1, wherein the deployed positions of the secondary chambers (18) are spaced apart from one another in a transverse direction across the vehicle (20).

3. A pedestrian airbag arrangement according to any preceding claim, wherein said primary chamber (5) and each said secondary chamber (18) are formed from flexible material (2,3,10,1 1,12), and wherein the material (10,1 1,12) forming each said secondary chamber (18) is connected to the material (3) forming the primary chamber (5).

4. A pedestrian airbag arrangement according to claim 3, wherein said flexible material (2,3,10,1 1,12) is fabric and the fabric (10,1 1,12) forming each said secondary chamber (18) is stitched to the fabric (3) forming the primary chamber (5).

5. A pedestrian airbag arrangement according to claim 1 or claim 2, wherein said secondary chambers (18) are formed integrally with the primary chamber (5).

6. A pedestrian airbag arrangement according to claim 5, wherein the airbag is formed from fabric material, the secondary chambers (18) and the primary chamber (5) being formed integrally via a one-piece weaving technique.

7. A pedestrian airbag arrangement according to any preceding claim, wherein each said secondary chamber (18) is provided in fluid communication (9) with said primary chamber (5).

8. A pedestrian airbag arrangement according to claim 7, further comprising an inflator (22) arranged to direct a volume of inflating gas (24) into said primary chamber (5) upon actuation, wherein each said secondary chamber (18) is arranged for inflation via a flow of said inflating gas (25) from said primary chamber (5).

9. A pedestrian airbag arrangement according to any preceding claim, wherein the inflatable volume of each said secondary chamber (18) is smaller than the inflatable volume of said primary chamber (5).

10. A pedestrian airbag arrangement according to any preceding claim, wherein the total inflatable volume of said secondary chambers (18) is smaller than the inflatable volume of said primary chamber (5).

11. A pedestrian airbag arrangement according to any preceding claim, wherein said primary chamber (5) and each said secondary chamber (18) have a substantially elongate configuration when inflated, and wherein the deployed position of each said secondary chamber (18) is generally orthogonal to the inflated position of the primary chamber (5).

12. A pedestrian airbag arrangement according to any one of claims 1 to 10, wherein said primary chamber (5) has a generally elongate and arcuate configuration when inflated, and each secondary chamber (18) has a substantially elongate configuration when inflated, the deployed positions of the secondary chambers (18) each being generally orthogonal to the respective adjacent regions of the primary chamber (5).

13. A pedestrian airbag arrangement according to claim 11 or claim 12, wherein each said secondary chamber (18) is connected along substantially its entire length to the primary chamber (5).

14. A pedestrian airbag arrangement according to any preceding claim, wherein each said secondary chamber (18) has an inflated configuration in which it presents a curved outer surface towards the windscreen (21) of the vehicle (20).

15. A pedestrian airbag arrangement according to any preceding claim, wherein said primary chamber (5) is sub-divided into a plurality of inflatable cells (28,29) in fluid communication (30) with one another, and each said secondary chamber (18) is provided in fluid communication (9) with at least one of said cells (29).

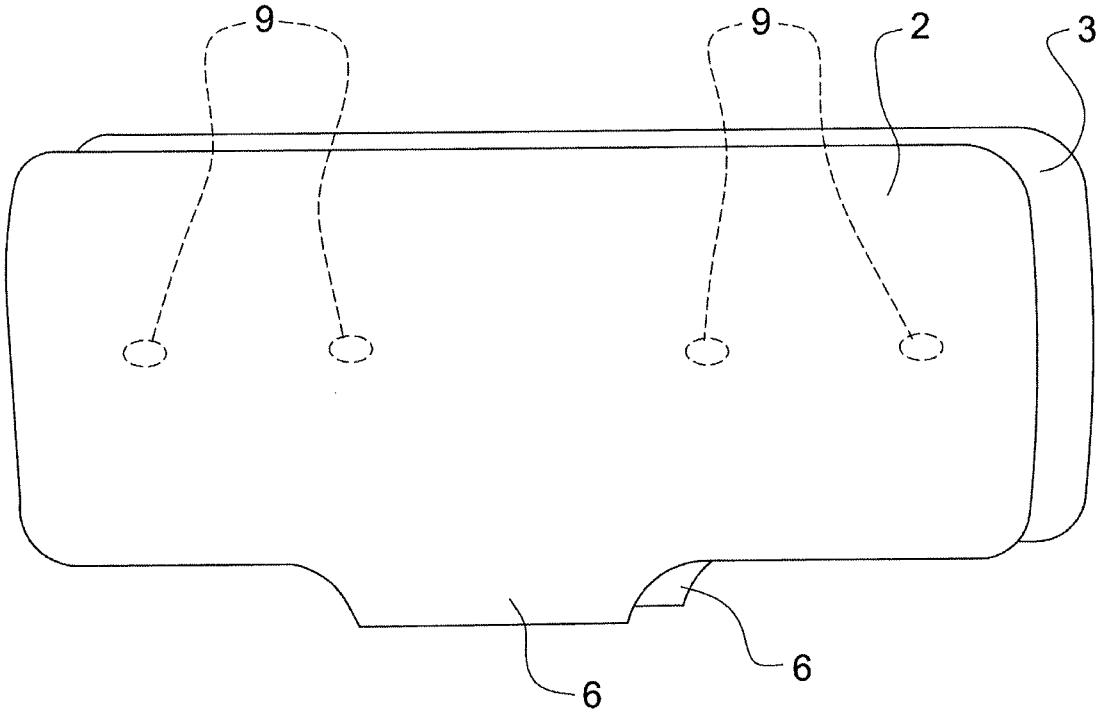


FIG 1

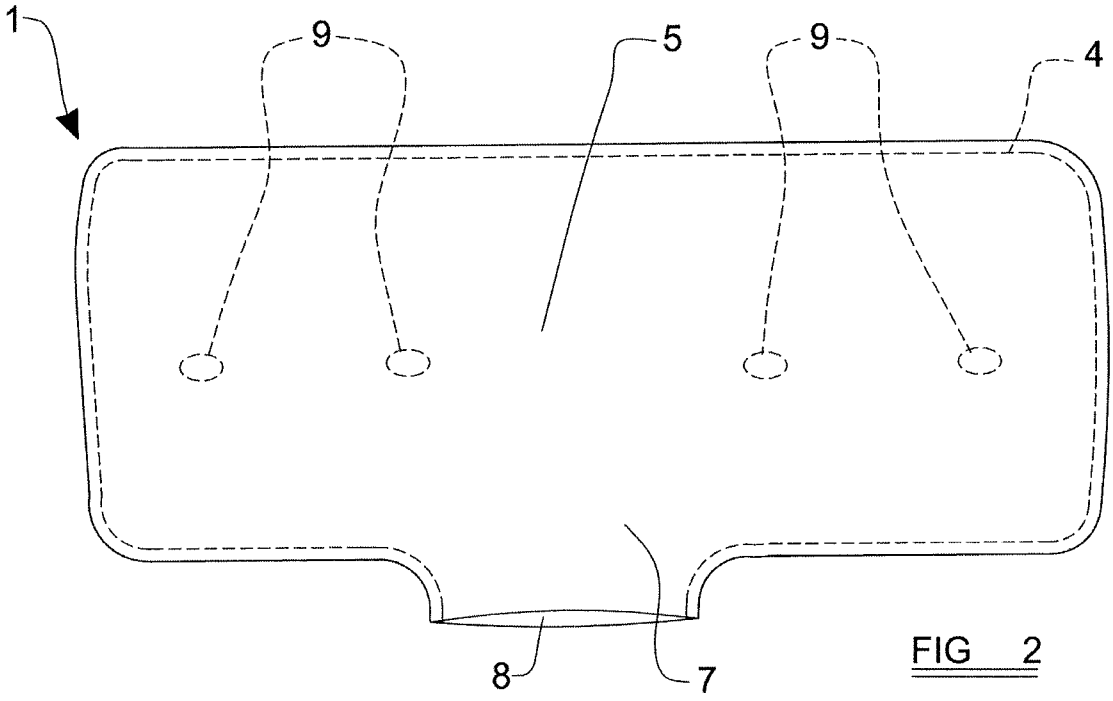
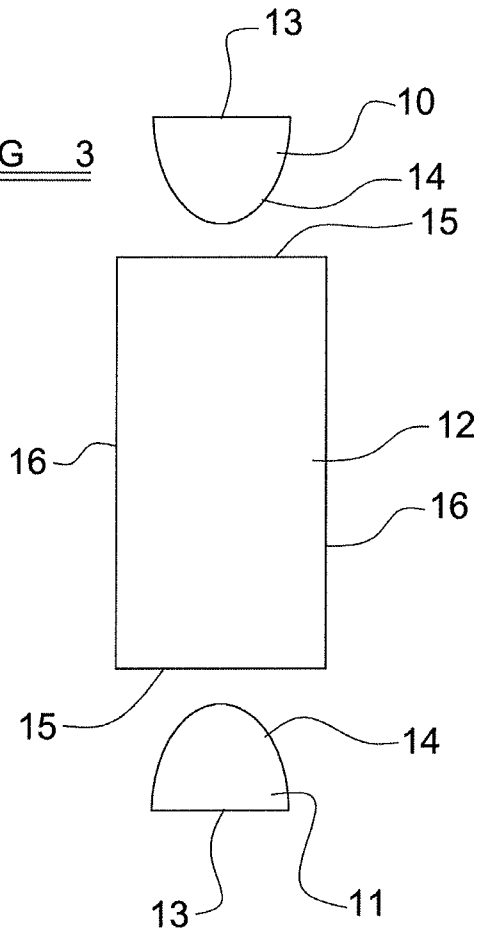


FIG 2

FIG 3



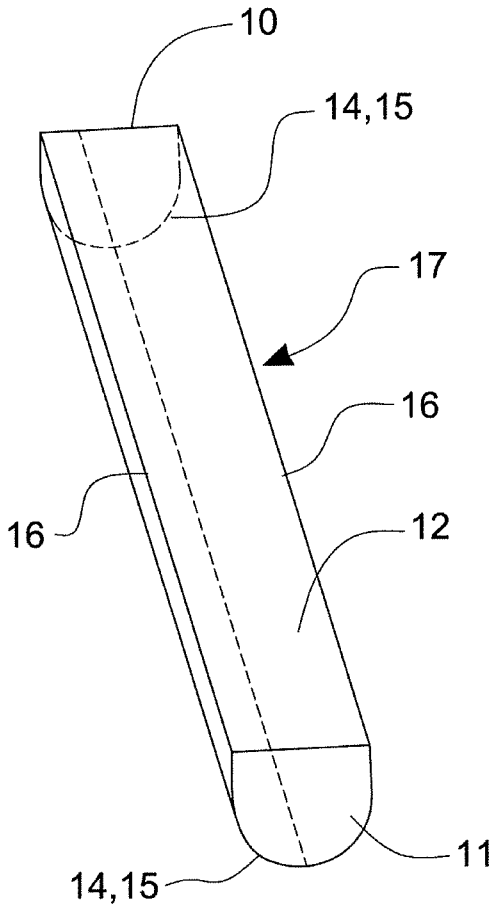
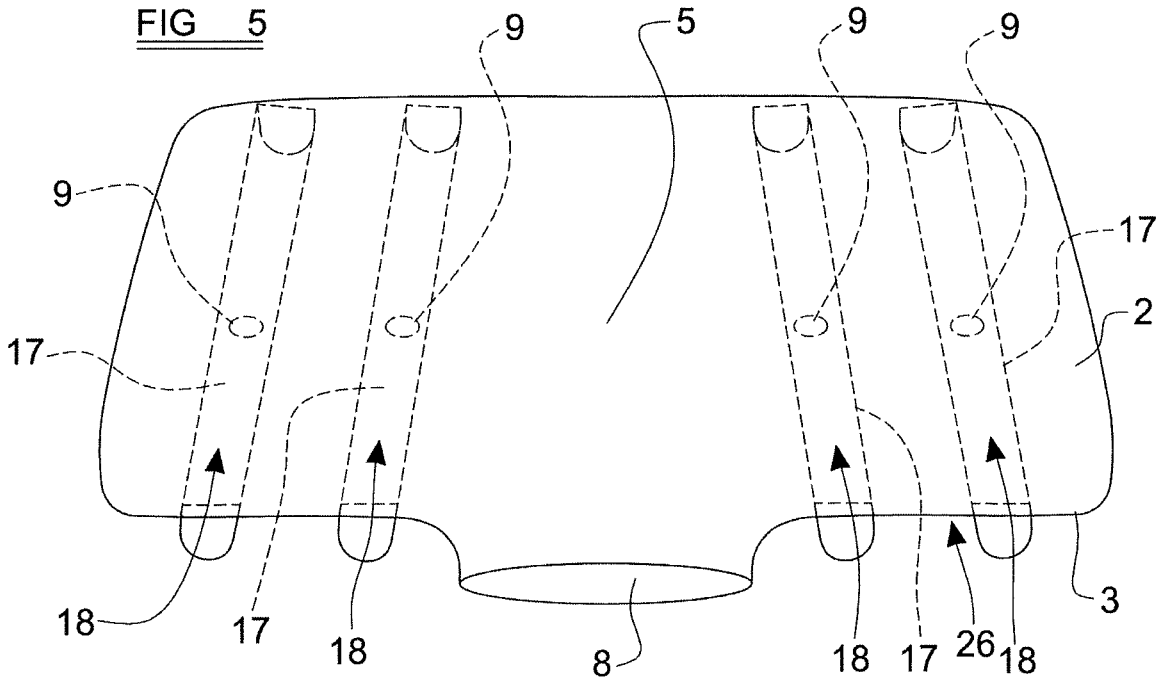


FIG 4

FIG 5



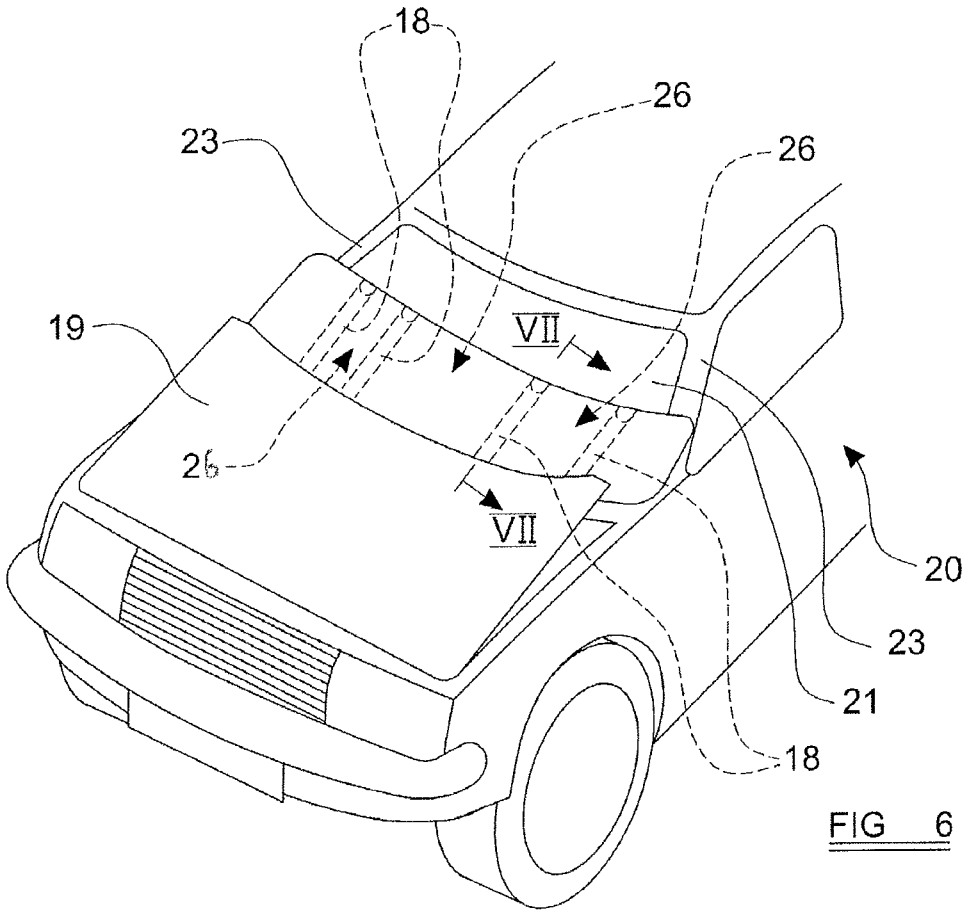


FIG 6

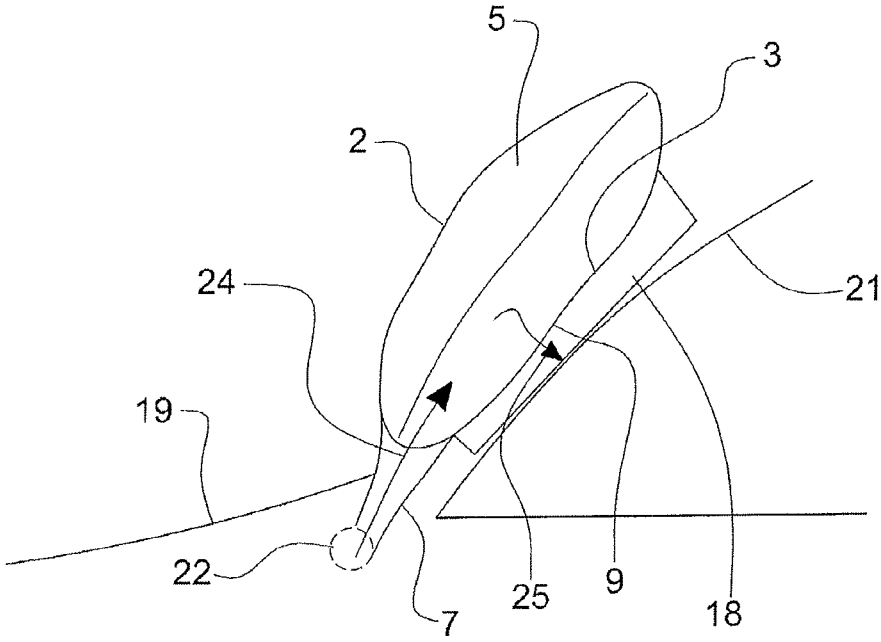


FIG 7

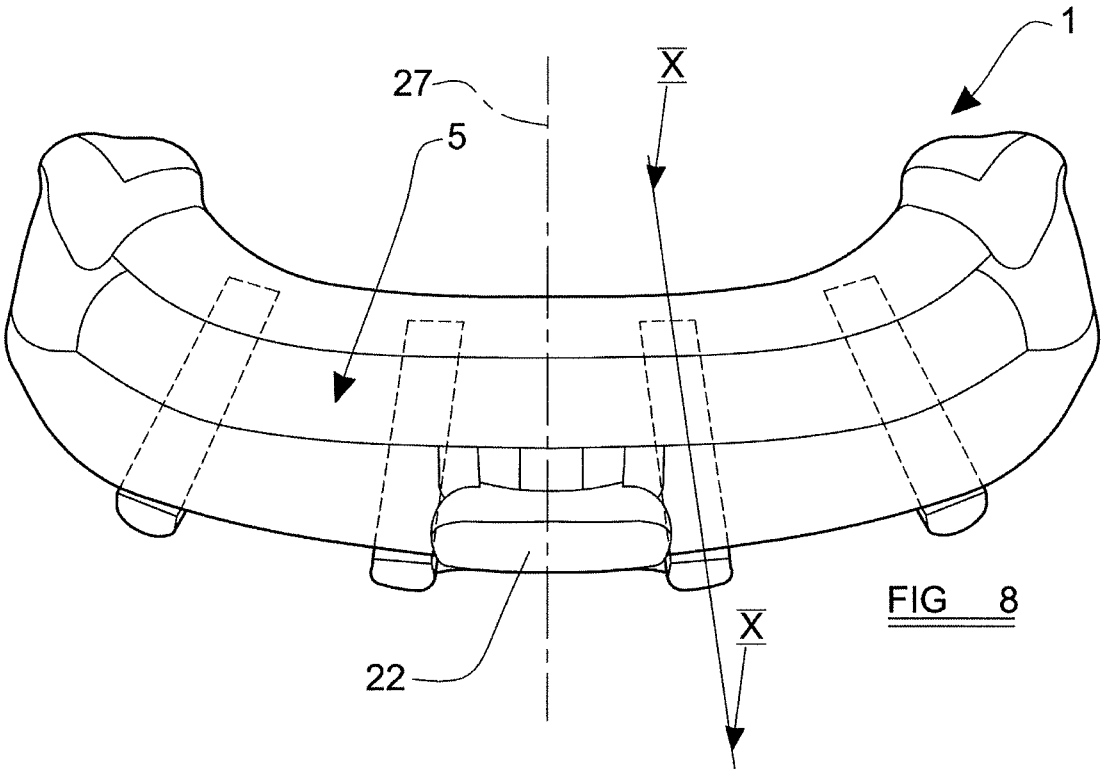


FIG 8

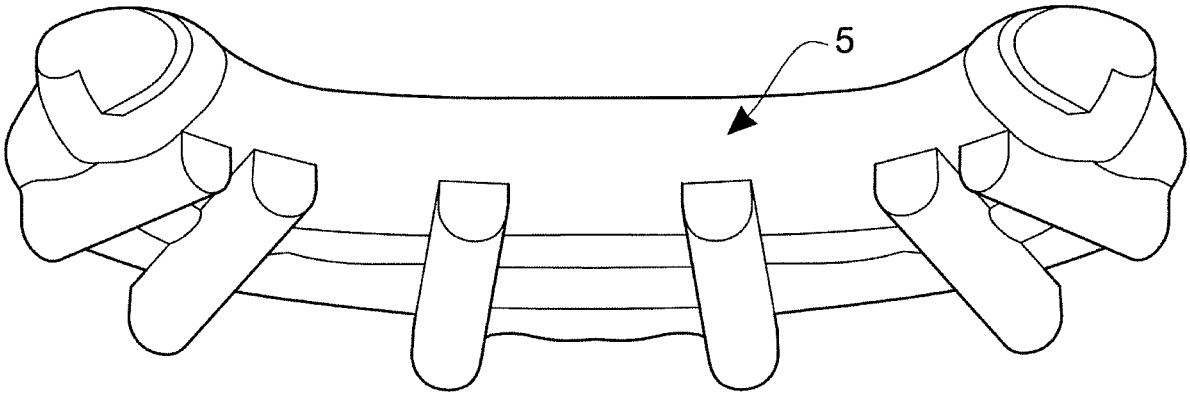


FIG 9

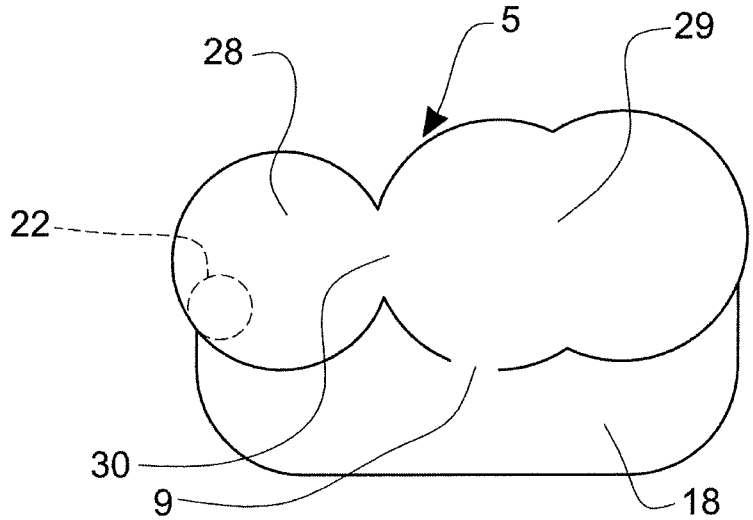


FIG 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE201 2/051 273

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: B60R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 200801 85823 A1 (KALLISKE INGO ET AL), 7 August 2008 (2008-08-07); paragraphs [0003], [001 8], [0022]-[0025], [0028]-[0032], [0046], [0055]; figures 2B, 4, 7	1-4, 7-1 5
Y	--	5-6
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☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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International Patent Classification (IPC)

B60R 21/36 (201 1.01)

B60R 21/233 (2006.01)

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