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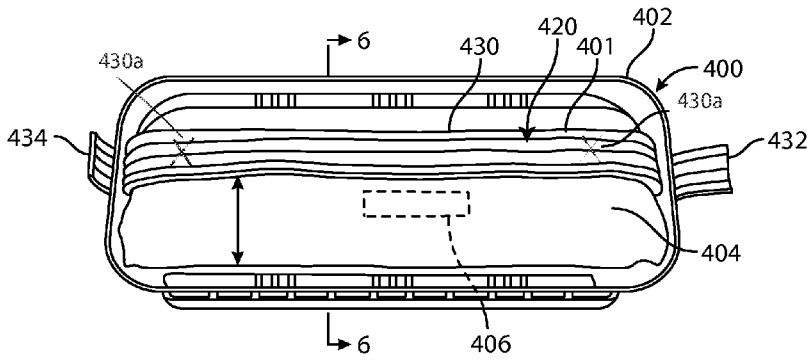

FIG. 3

(57) Abstract: An airbag module (400) has a housing (402), an airbag (404), an inflator (406) and a deflector mechanism (420) which provides a barrier or guide and a reaction hood 401 or surface to modify the trajectory of the airbag on inflation to inflate at a lower trajectory. The deflector mechanism (420) has a tensioning member (430).

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AIRBAG MODULE WITH EXTERNAL DEFLECTOR

Background and Summary of the Invention

[0001] The present invention relates generally to airbags and more specifically to an apparatus for changing the trajectory of an inflating airbag to reduce the impact force of the airbag upon the windshield.

[0002] Figure 1 diagrammatically illustrates a typical passenger compartment 20 of a vehicle showing opposing A-pillars 22, a windshield 24 and instrument panel 26. Situated on the top 28 surface of the instrument panel is a deployment door 30. The windshield is oriented relative to the top surface at an angle A which varies from about 20 degrees to 60 degrees. The door 30 is part of an instrument panel. Situated below the instrument panel is an airbag module 40 of known variety comprising: an airbag 42, an inflator 44 and a housing 46. The door 30 is capable of being separated from the rest of the instrument panel 26 upon deployment/inflation of airbag 42. Typically a plurality of stress risers or a weakened portion or tear seam 56 is fabricated in the instrument panel about the door 30. These stress risers/weakened portion/tear seam 56 are designed to rupture permitting the door to rotate toward the instrument panel, as illustrated in figure 2. As the door moves, the airbag 42 continues to inflate. This operation is designed to occur at the modest level of airbag internal pressure. The stress risers or tear seam 56 are designed to break at a modest internal airbag pressure to prevent propellant of the deployment for forcefully against the windshield.

[0003] Occasionally the weakened portions 56 do not break as designed, consequently, the airbag 42 will continue to inflate and press upon the underside of the door 30 with increasing force. When the weakened portions 56 finally break, the airbag 42 deploys outwardly with great force and the airbag 42 and door 30 are pushed against the windshield with an impulsive force F1 which can be sufficiently high to crack the windshield.

[0004] It is an object of the present invention to correct the deficiencies in the prior art.

Brief Description of the Drawings

[0005] Figure 1 diagrammatically illustrates a typical windshield and instrument panel of the vehicle.

[0006] Figure 2 is a cross-sectional view showing an inflating passenger side airbag.

[0007] Figure 3 illustrates one embodiment of the present invention.

[0008] Figure 4 illustrates a close-up view of the external tether.

[0009] Figures 5A – 5D show various ways of connecting the external tether to the airbag module housing.

[0010] Figure 6 is a cross-sectional view taken through section 6-6 of figure 3.

[0011] Figure 7 diagrammatically illustrates an external deflector.

[0012] Figure 8 is a cross-sectional view showing a deflector, airbag and inflator.

[0013] Figure 9 is a plan view of the component parts of an external deflector.

[0014] Figure 10 is a top view showing an external deflector in an operative relationship to the folded airbag within the housing.

[0015] Figure 11 shows the operation of the present invention.

[0016] Figure 12 shows an alternate embodiment of the invention.

[0017] Figure 13 shows a further embodiment of the invention.

[0018] Figure 14 shows a further embodiment of the invention.

[0019] Figures 15 and 16 show the comparative improvement in performance created by the present invention

Detailed Description of the Drawings

[0020] Reference is made to figure 3 which illustrates an airbag module 400 of the present invention comprising a housing 402, airbag 404 and inflator 406. In general terms, this portion of the invention is rather conventional. Module 400 further includes a deflector mechanism 420 which provides a barrier or guide as well as a reaction hood or surface to modify the trajectory of the inflating airbag so the airbag tends to inflate at a lower expanding trajectory than without the barrier or guide. This trajectory correction discourages the airbag from impacting the windshield at the lower portions of the windshield thereby lessening the applied force to the windshield and reducing the risk of windshield damage. In a first embodiment of the invention the deflector mechanism comprises a tensioning member 430, which in the first illustrated embodiment is configured as a length of seat belt webbing, or similar band, 430a secured to a reaction hood 401. In other embodiments the tensioning member is formed by overlapping layers of the reaction hood or alternatively by wires or ropes secured to the reaction hood. As will be seen below, the reaction hood 401 partially covers the folded airbag 404 preventing the airbag from deploying forward of the tensioning member 430 (that is closer to the windshield), for example see figures 3, 7 and 8. The tensioning member 430 includes opposing ends at 432 and 434 that are secured to housing 402. In the embodiment illustrated in figure 3, for example, the ends 432 and 434 are secured to sides 436 of the housing. Only one side 436 of the housing is visible in figure 4. The tensioning member 430 is secured to a top portion of the reaction hood 401 by a suitable means. In the illustrated embodiment the tensioning belt 430a is secured by stitches to the reaction hood 401.

[0021] The respective ends 432 and 434 of the tensioning belt can be attached to the housing in a variety of ways, see figures 5A – 5D. As illustrated in figure 4, as well as in figure 5A, each end of the webbing 432,434 is formed into a loop 450 with an extending member or arm 452. The end of the webbing is folded onto itself and sewn together to form the

loop. Numeral 454 shows the sewing threads. The webbing loop is pulled through a hole 460 formed on the housing at any convenient location, for example, on the side or on a horizontal lip. The center portion 431 of tensioning member 430 and the extending member 452 provide a barrier to keep the webbing in place. Figure 5B shows an alternate method of securing the webbing 430 to the housing 402. If housing 402 is plastic the webbing can be sewn to the plastic housing, for example, at its sides. In figure 5C the webbing 430 is secured to the housing by rivets 466. In figure 5D the ends of the webbing are formed into a loop 471; a pin 472 is inserted within the loop. The diameter of the loop, with the pin in place, is designed to be wider than the hole 460 in the housing. Other attachment mechanisms are within the spirit of the present invention.

[0022] Reference is made to figures 6 – 9. Figure 6 is a cross-sectional view of module 400 taken through section line 6-6 of figure 3. In figure 6, inflator 406 has been placed within airbag 400 in a conventional manner and then the airbag is folded into a compact configuration. As is well known in the art the folded airbag is kept in this configuration by enveloping the airbag with a lightweight, tearable cover 405 which covers all of the multiple sides and ends of the folded airbag.

[0023] Figure 7 shows the tensioning member 430 secured to the reaction hood 431, the folded airbag, with its cover 405 protectively enveloping the airbag, with its inflator 406 positioned therein, and is slid partially into the reaction hood 431. This configuration is shown in figure 7 with a portion of the folded airbag 404 and its hood 405 extending outwardly from the tensioning member 430, which in essence defines the outward edge of the reaction hood 431. Reference is also briefly made to figure 8 which is a cross-sectional view taken through section line 8-8 of figure 7. The relationship amongst the airbag 404, cover 405, reaction hood 431 and the tensioning member 430 is illustrated.

[0024] Figure 9 is an isolated view of deflector 420 illustrating the tensioning member 430 and the reaction hood 431 laid flat. The reaction hood includes a plurality of opposing extending legs 460, each of which

includes a mounting hole 461. An edge portion 462 of hood 431 is positioned below the tensioning member or belt which forms the front of the deflector 420. Located opposite edge portion 462 is a generally rectangular shaped portion 464 having mounting holes 461. With hood 431 placed atop the folded airbag, legs 460 are pulled down so that mounting openings 461 can be placed about the mounting studs 470 of inflator 406. This movement covers the right and left sides or ends of the folded airbag. Subsequently, portion 464 of the hood is moved downwardly so that mounting holes 461 can also be secured to the studs 470. This motion moves the hood 431 into a covering condition over the rear of the top of the airbag, the rear side or surface of the folded airbag, and the rear portions of the bottom section of the folded airbag. When this subassembly, as illustrated in figure 8, is inserted within housing 402 the reaction hood is secured in place, once the inflator is secured by additional fasteners to the housing.

[0025] Reference is briefly made to the phantom region 600 of figure 9 which identifies an alternate embodiment of the invention. This region 600 is an extension of the material used to form the reaction hood 431 and is used to replace the belt 430a used in the earlier embodiment. With the belt 430a removed from hood 431, the material of region 600 is folded back upon itself to create a number of folds 602 as illustrated in figure 12. This process creates an alternate tensioning member with sides 432 and 434. Reference is also made to figure 13 which illustrates a further embodiment in which the tensioning member 430 is formed by a plurality of wires or ropes 700 secured to a portion of hood 431. These wires or ropes can be terminated at a loop 704 which can be secured to the module housing or alternatively wrapped about the airbag and secured to the inflator mounting fasteners 470. This alternate mounting of the tensioning member is true of the belt 430a and the folded material 602.

[0026] Reference is briefly made to figure 10 which illustrates with phantom lines 484 and 482 to show the tensioning member 430 can be moved rearward, in relation to figure 10, to align with phantom line 484 or moved forward, in relation to figure 10, to align with phantom line 482. As

can be appreciated the placement of the tensioning member affects the inflation trajectory of the airbag. Reference is again made to figures 7 and 10. The width of the tensioning member 430 is shown by W; the width of the opening in the airbag housing is shown as W1. Dimension S1 is the distance between the rear surface of the tensioning strap and the rear of the mouth or opening of the housing while dimension S2 is the distance between the forward edge of the tensioning strap 430 and forward edge of the mouth of the housing 402. In the preferred embodiment of the invention the dimensions are as follows W = 47mm, W1 =95mm, S1= 30mm and S2 = 20 mm.

[0027] Figure 11 shows the present invention mounted in a typical instrument panel 26, the top of which is at an angle of A relative to windshield 24. Instrument panel 26 includes a recessed portion or chute 27 under which housing 402 is mounted. This mounting can be accomplished in any conventional matter. During an accident, a signal is generated which in turn causes inflator 406 to generate inflation gas which is communicated to the folded airbag 404. As the airbag inflates it breaks its cover 405 and creates a tension T across the tensioning belt 430 which stiffens the forward edge of the reaction hood 431. The reaction hood, as previously described, is also affixed to the inflator 406 and with the tensioning member in tension, the reaction hood acts as a reaction surface, which prevents forward movement of the air bag 404 in the forward direction of 550, that is toward the windshield. The inflating airbag 404 reacts against the reaction hood and exits from the instrument panel with a component of rearward momentum adding more tangential angle to the windshield, lessening impact with the windshield. The tensioned tensioning member 430 prevents the air bag from exiting the housing and instrument panel in a general upward direction further lessening impact with the windshield. As can be appreciated, the material characteristics and in particular the material characteristics of the tensioning member 430 and deflector 420 control the trajectory of the inflating airbag. Additionally, the initial tension T in the tensioning member 430 can also contribute to the control of the airbag trajectory. Figure 14

illustrates an alternate exterior deflector 500 is constructed substantially of the tensioning member 430 which is sufficiently wide to prevent the airbag from exiting side 406 of this webbing which is located toward the front of the vehicle. Additionally this tensioning member can be formed with a molded or raised center portion 502 which will encourage the airbag to move outward along arrow 504.

[0028] Figures 15 and 16 show the result of a dynamic test in which a reactive film 800 was placed upon the inside surface of the windshield. When the airbag inflated the impact of the airbag pressed against the reactive film creating an imprint or pressure profile of the forces generated by the airbag upon the inner surface of the windshield. Figure 15 shows the performance of a base system without the external deflector. The color pattern and intensity of colors shows the force of the airbag against the windshield. The dimension X1 shows the location of the force profiles relative to the windshield. Figure 16 illustrates the operation of the similarly sized airbag but one which is guided by the external deflector 420. As can be seen the reactive film left a substantially lower or lessened profile on the inner surface of the windshield indicating improved performance resulting from the present invention. Visually, the intensity of the force profiles upon the film are so reduced that for the purpose of printing and visualization outlines have been placed about these force profiles shown.

[0029] Variations in the present invention are possible in light of the description of it provided herein. While certain representative embodiments and details have been shown for the purpose of illustrating the subject invention, it will be apparent to those skilled in this art that various changes and modifications can be made therein without departing from the scope of the subject invention. It is, therefore, to be understood that changes can be made in the particular embodiments described which will be within the full intended scope of the invention as defined by the following appended claims.

CLAIMS

What is claimed is:

1. An airbag module (400) comprising:

a housing (402);

an airbag (404);

an inflator (406); and

a deflector mechanism (420) which provides a barrier or guide and a reaction hood or surface (401) to modify the trajectory of the airbag 404 on inflation to achieve one or both of: a) to inflate at a lower trajectory, and b) lowers impact force with a windshield.

2. The airbag module (400) of claim 1 wherein the deflector mechanism (420) has a tensioning member (430).

3. The airbag module (400) of claim 2 wherein the tensioning member (430) is a length of band including a seat belt webbing (430a) secured to the reaction hood (401).

4. The airbag module (400) of claim 2 wherein the reaction hood (401) is made of one or more layers and the tensioning member (430) is formed by overlapping layers of the reaction hood (401).

5. The airbag module of claim 2 wherein the tensioning member (430) is formed by wires or ropes secured to the reaction hood (401).

6. The airbag module (400) of claim 2 wherein the tensioning member (430) further comprises opposing ends secured to the housing (402).

7. The airbag module (400) of claim 6 wherein the tensioning member (430) is secured to the housing (402) at sides (436) of the housing (402).

8. The airbag module (400) of claim 2 wherein the reaction hood (401) partially covers the airbag (404) when folded in the housing (402) preventing the airbag (404) when deployed from moving forward of the tensioning member (430) and closer to a windshield.

9. The airbag module (400) of claim 2 wherein the tensioning member (430) is secured to a top portion of the reaction hood (401).

10. The airbag module (400) of claim 7 wherein the tensioning member (430) is secured to a top portion of the reaction hood (401).

11. The airbag module (400) of claim 3 wherein the respective ends (432), (434) of the tensioning member (430) is attached to the housing (402) by forming a loop (450) with an extending member or arm (452) at each end (432, 434) of the webbing (430a) and each webbing loop (450) is pulled through a hole (460) on the housing (402) on each side (436) or a horizontal lip of the housing (402).

12. The airbag module (400) of claim 11 wherein the end of the webbing (430a) is folded onto itself and sewn together to form the loop (450).

13. The airbag module (400) of claim 3 wherein the housing (402) is made of a plastic material and the webbing (430a) is sewn to sides (432) of the housing (402).

14. The airbag module (400) of claim 11 wherein a pin(472) is inserted in each loop (471), causing the diameter of the loop (471) with the pin (472) in place to be wider than the hole (460) in the housing (402).

15. The airbag module (400) of claim 4 wherein the reaction hood (401) is made of a material, the material including an extension of the material which is folded back upon itself to form a number of folds to form the tensioning member (430) secured to the sides (436) of the housing (402).

16. The airbag module (400) of claim 2 wherein the tensioning member (430) is a strap (430) having a width W, the housing has an opening (W1, S1) is a distance between a rear surface or edge of the tensioning strap (430) and the rear edge of the housing opening (436, S2) is a distance between a forward edge of the tensioning strap (430) and the forward edge of the opening or mouth of the housing (402), wherein placement of the tensioning member (430) can be used to adjust the inflation trajectory.

17. The airbag module (400) of claim 16 wherein the placement of the tensioning member (430) is as follows: W= 47 mm, W1 = 95mm, S1 = 30 mm and S2 = 20 mm.

18. The airbag module (400) of claim 2 wherein the reaction hood (401) is affixed to the inflator (406) and the housing (402) and the tensioning member (430) and upon inflation of the airbag (404) creates a tension in the tensioning member (430) stiffening the forward edge of the reaction hood 401, the reaction hood (401) acts as a reaction surface preventing forward movement of the airbag (404) toward the lower windshield.

19. The airbag module (400) of claim 18 wherein the tensioning member (430) further prevents the airbag movement in a general upward direction to further lessen the airbag (404) impact with the windshield.

20. The airbag module (400) of claim 19 wherein the tensioning member 430 upon inflation of the airbag (404) has an initial tension T, the tension T

established by the physical and material characteristics of the tensioning member (430) and deflector (420) to control the airbag trajectory.

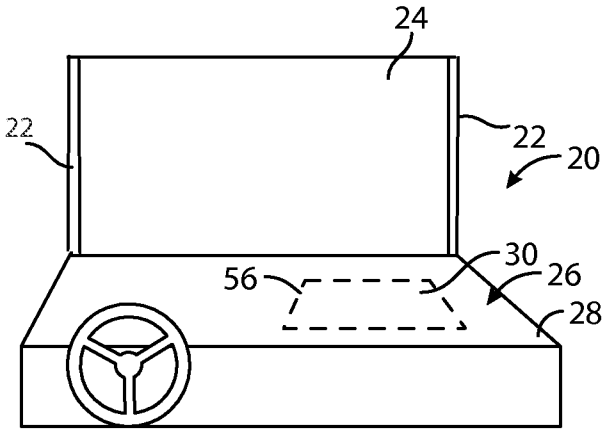

FIG. 1
(Prior Art)

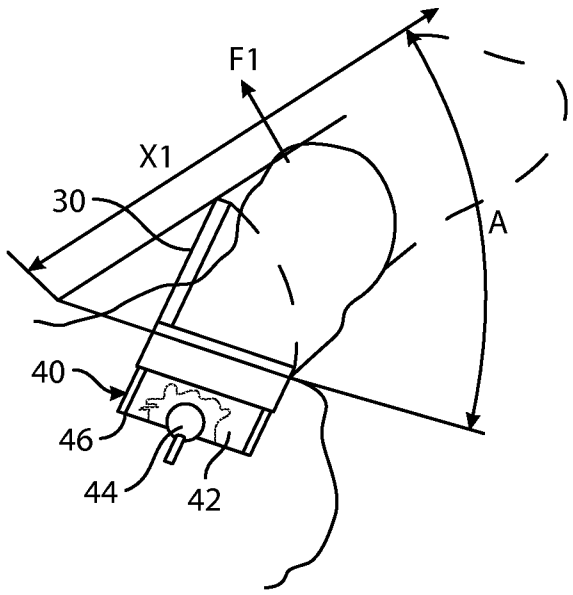

FIG. 2
(Prior Art)

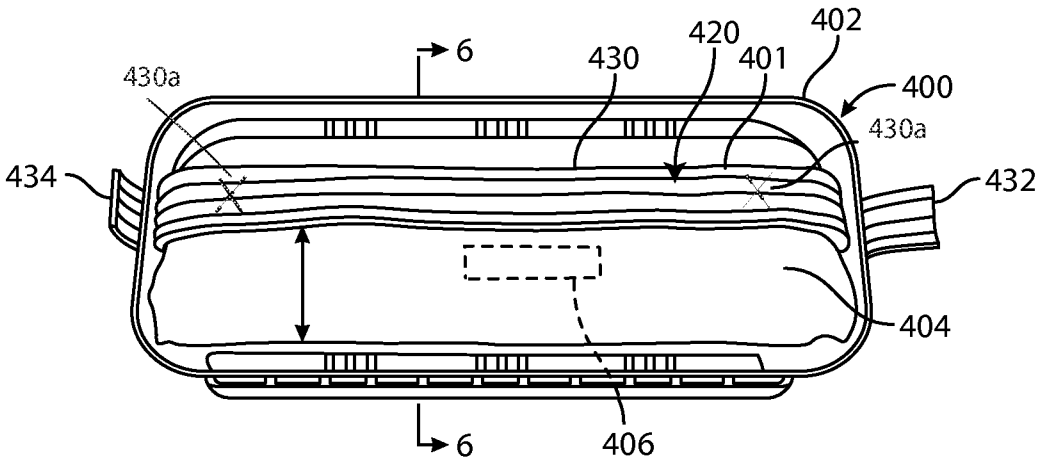

FIG. 3

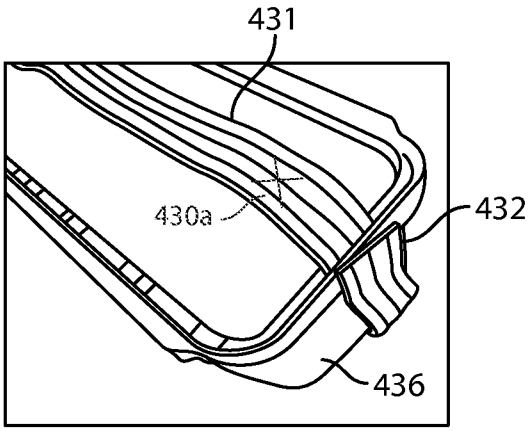

FIG. 4

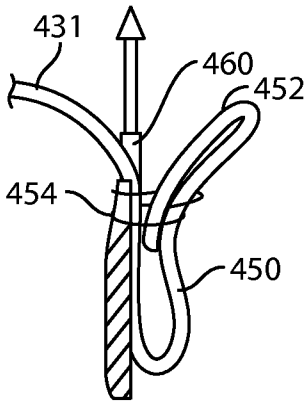

FIG. 5A

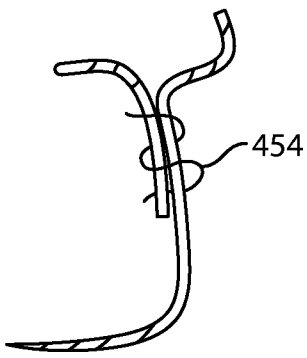

FIG. 5B

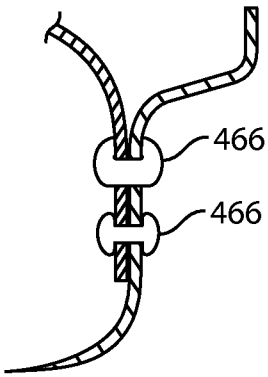

FIG. 5C

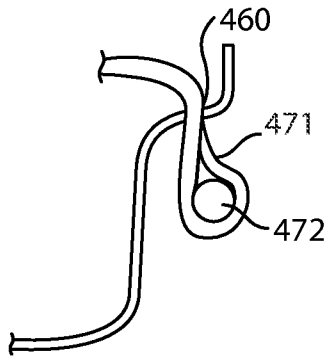

FIG. 5D

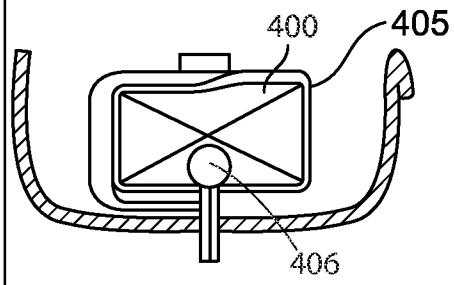

FIG. 6

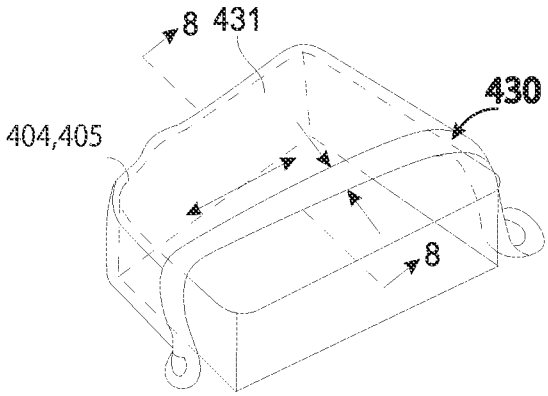

FIG. 7

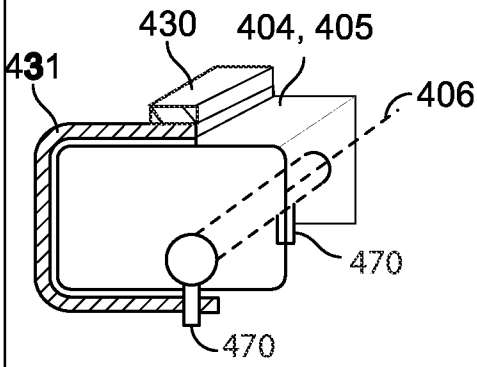

FIG. 8

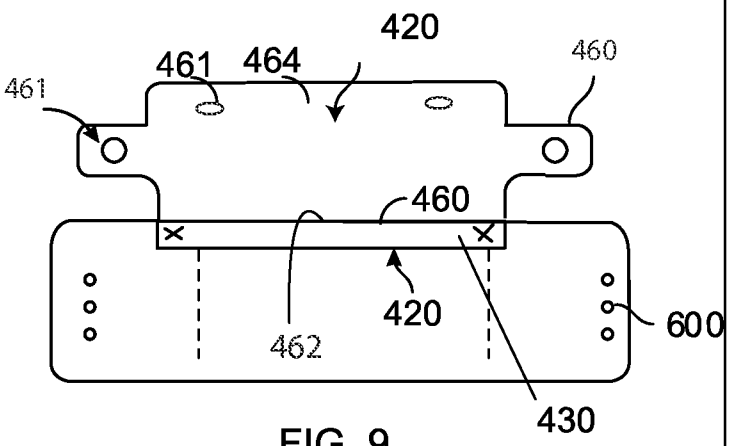

FIG. 9

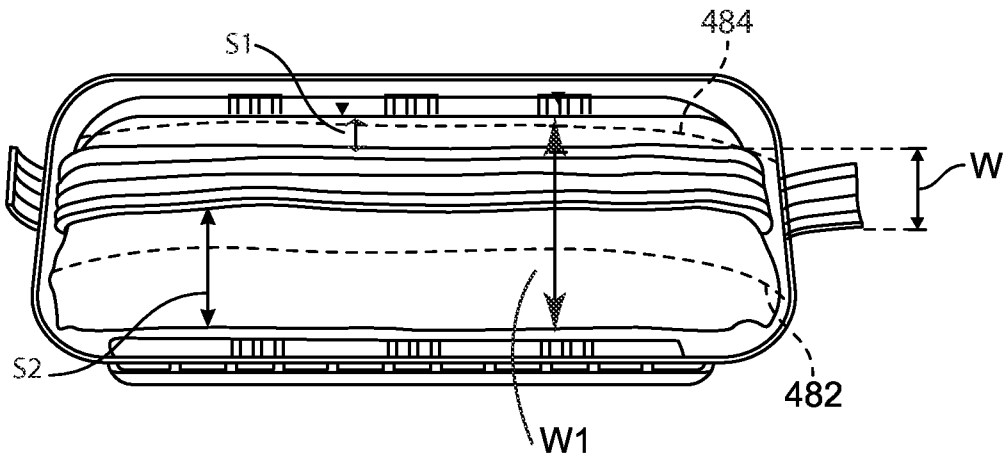

FIG. 10

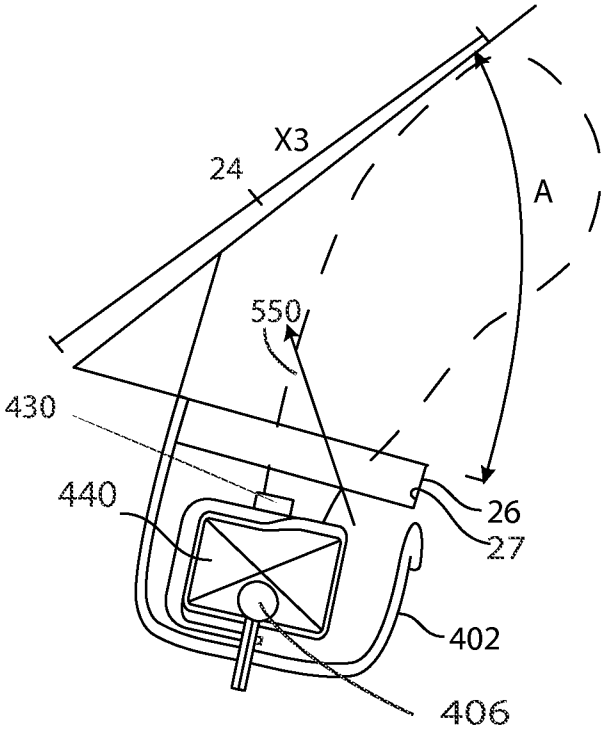

FIG. 1 1

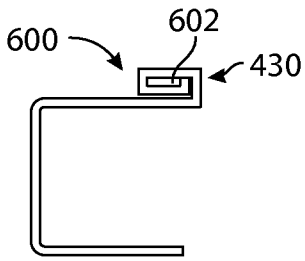

FIG. 12

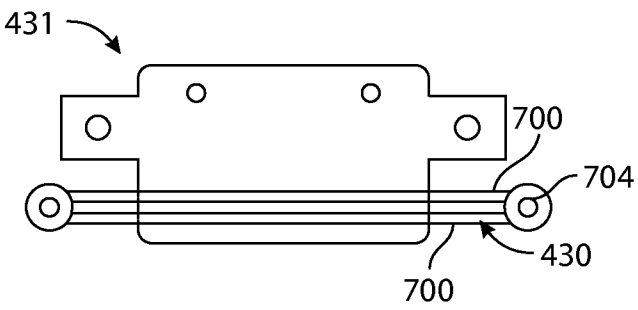

FIG. 13

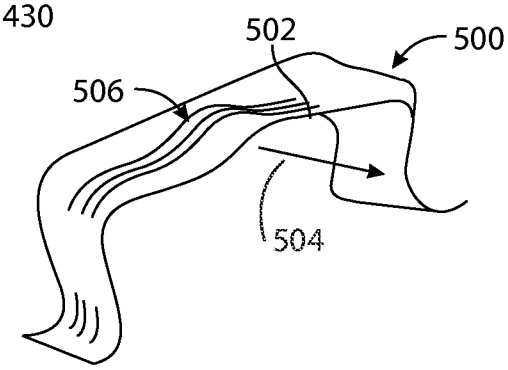

FIG. 14

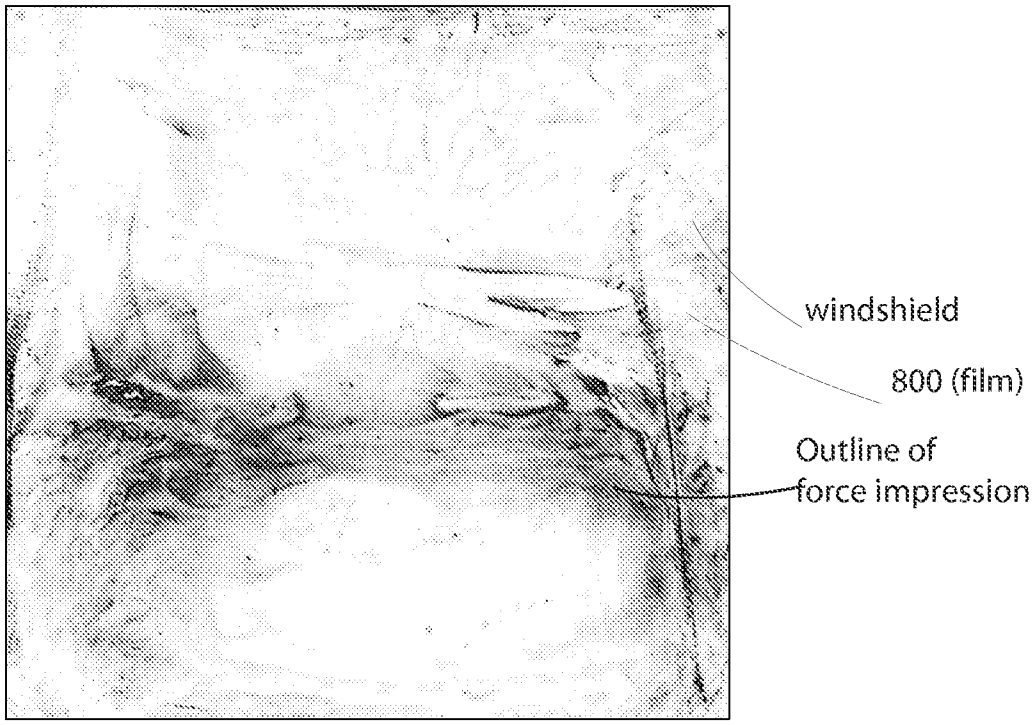
windshield
800 (film)
Outline of
force impression

FIG. 15

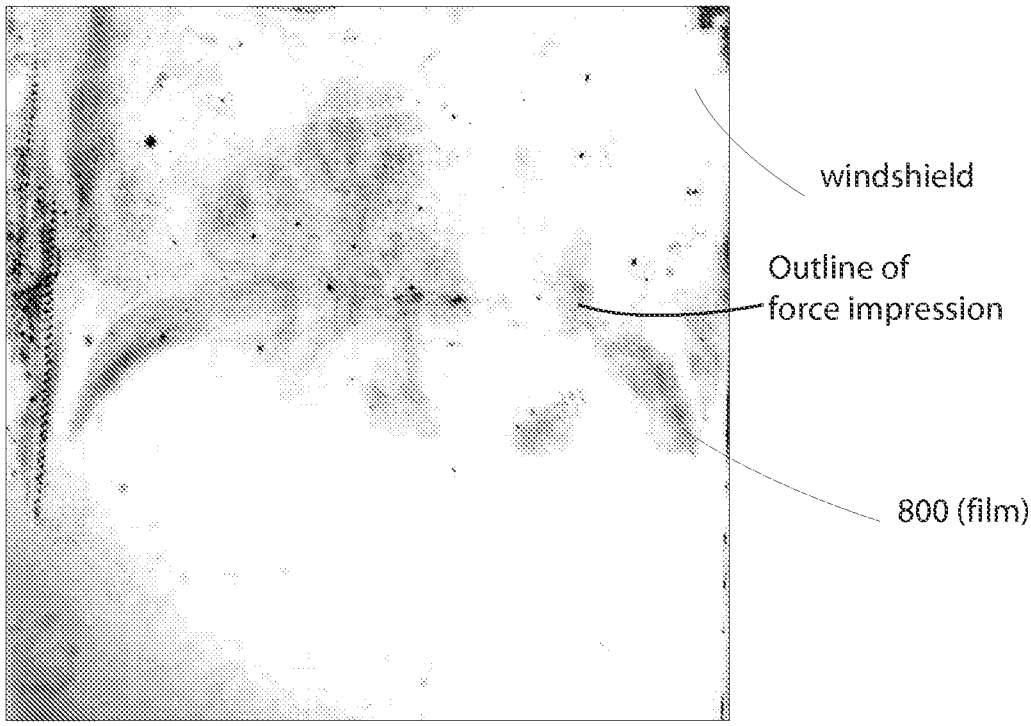
windshield
Outline of
force impression
800 (film)

FIG. 16

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/051021

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60R21/205
ADD.

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)
B60R

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, 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 Y	DE 10 2010 051421 A1 (TRW AUTOMOTIVE GMBH [DE]) 24 May 2012 (2012-05-24) paragraph [0001] - paragraph [0035]; figures -----	1,2,6-10 3
Y	US 5 385 366 A (FRANK FREDERICK W [US] ET AL) 31 January 1995 (1995-01-31) column 2, line 35 - column 4, line 37; figures -----	3

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 August 2013	11/11/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	David, Pascal

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/051021

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-3, 6-10

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-3, 6-10

   The length of band includes a seat belt webbing.

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2. claims: 4, 15

   The reaction hood is made of one or more layers and the tensioning member is formed by overlapping layers of the reaction hood.

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3. claim: 5

   The tensioning member is formed by wires or ropes secured to the reaction hood.

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4. claims: 11, 12, 14

   The respective ends of the tensioning member is attached to the housing by forming a loop with an extending member or arm at each end of the webbing and each webbing loop is pulled through a hole on the housing on each side or a horizontal lip of the housing.

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5. claim: 13

   The housing is made of a plastic material and the webbing is sewn to sides of the housing.

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6. claims: 16, 17

   The housing has an opening being a distance between a rear surface or edge of the tensioning strap and the rear edge of the housing opening, wherein placement of the tensioning member can be used to adjust the inflation trajectory.

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7. claims: 18-20

   The reaction hood is affixed to the inflator and the housing and the tensioning member and upon inflation of the airbag creates a tension in the tensioning member stiffening the forward edge of the reaction hood, the reaction hood acts as a reaction surface preventing forward movement of the airbag toward the lower windshield.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2013/051021

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 102010051421 A1	24-05-2012	CN 102529869 A	04-07-2012
		DE 102010051421 A1	24-05-2012
		US 2012267881 A1	25-10-2012
US 5385366 A	31-01-1995	NONE	