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(54) Abstract Title
A roof deployed air bag for a rear passenger

(57) An air-bag is provided for protecting an occupant of a seat of a motor vehicle. The air-bag is to be mounted to the vehicle by mountings. When inflated the air-bag extends downwardly from the roof of the vehicle to occupy a position in front of an occupant of the seat of a vehicle. Each mounting is adapted to release the inflatable element in response to a force having a substantial forward component applied to the air-bag, or in a response to an accident situation when a seat of the vehicle is occupied by an un-belted seat occupant. If there is an un-belted occupant, the air-bag in front of the occupant will be disconnected from the roof, preventing undesirable neck injuries occurring. If the seat occupant is belted, then the air-bag will remain in position in front of the occupant.

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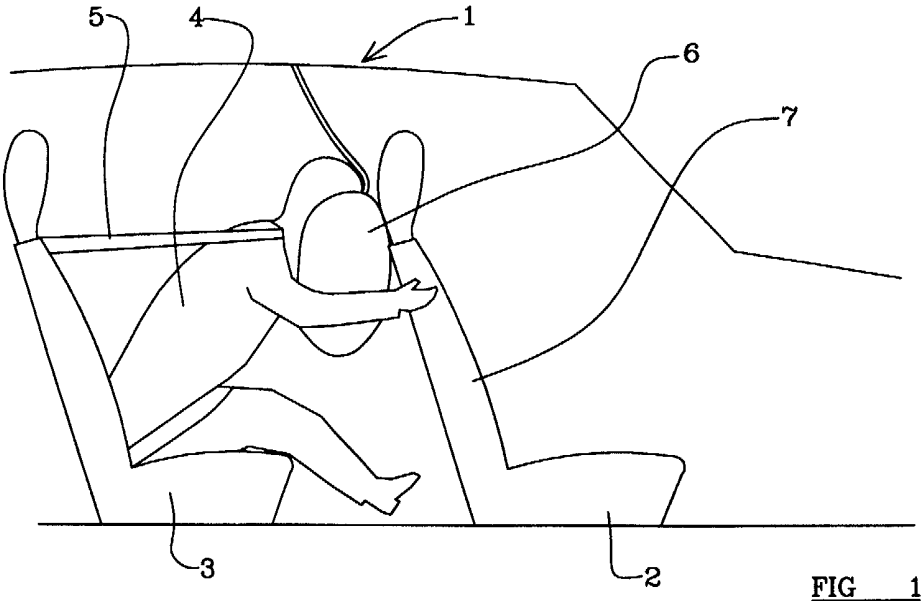


FIG 1

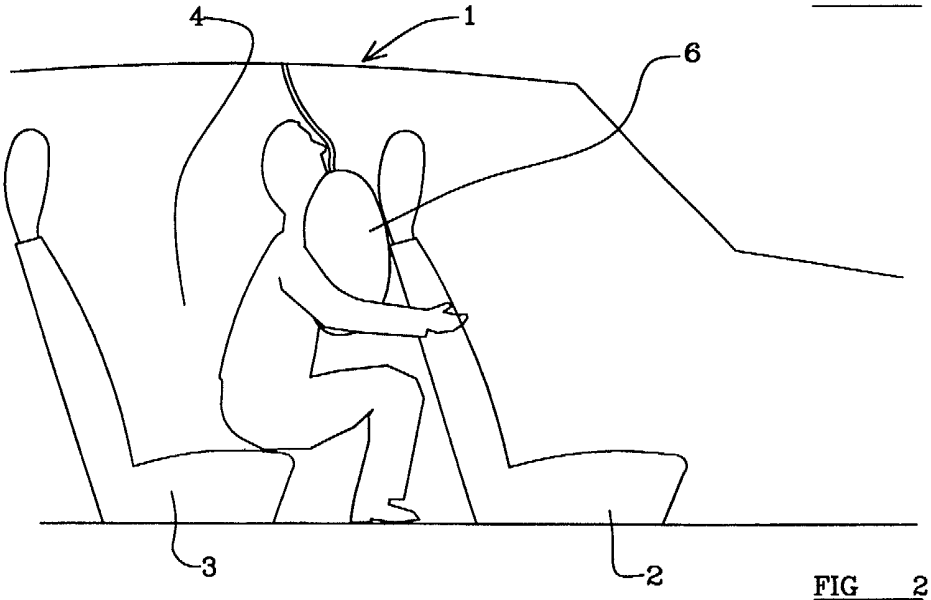


FIG 2

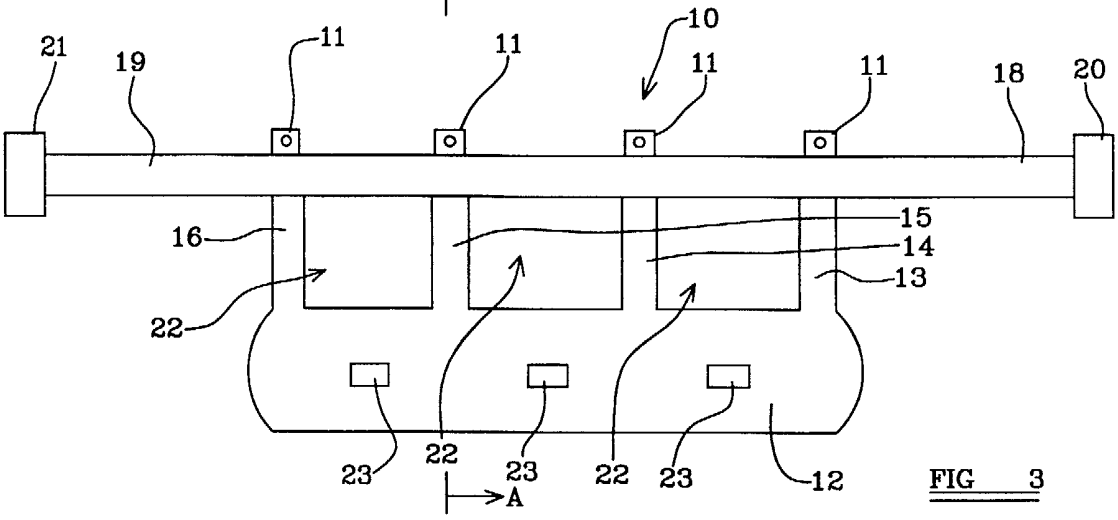


FIG 3

FIG 6

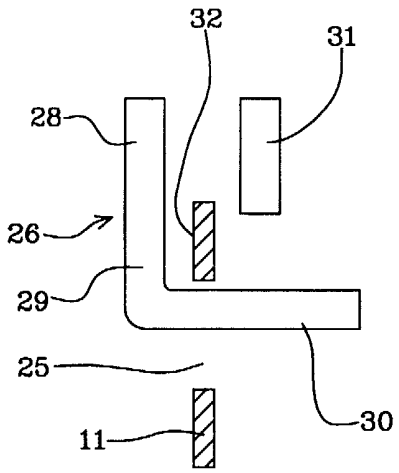


FIG 7

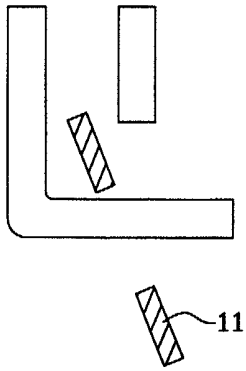
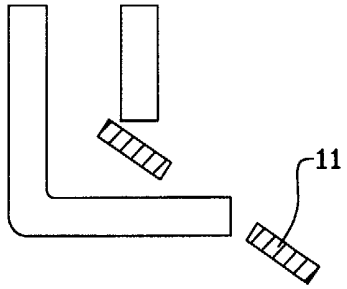


FIG 8



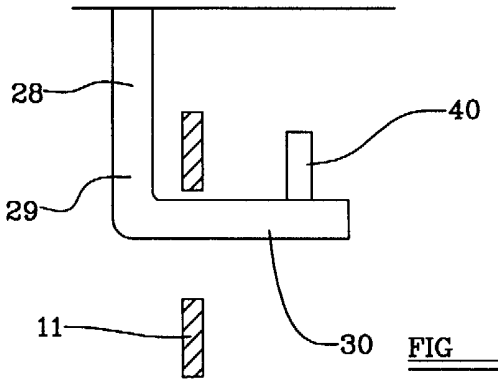


FIG 9

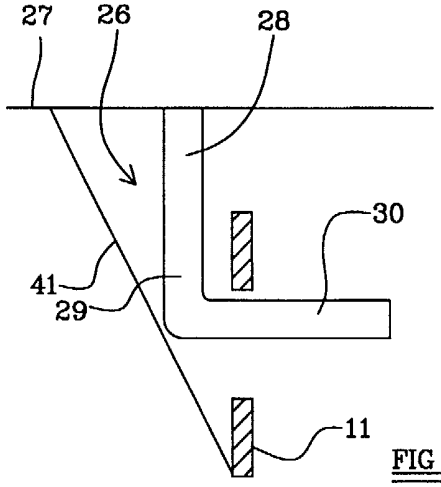


FIG 10

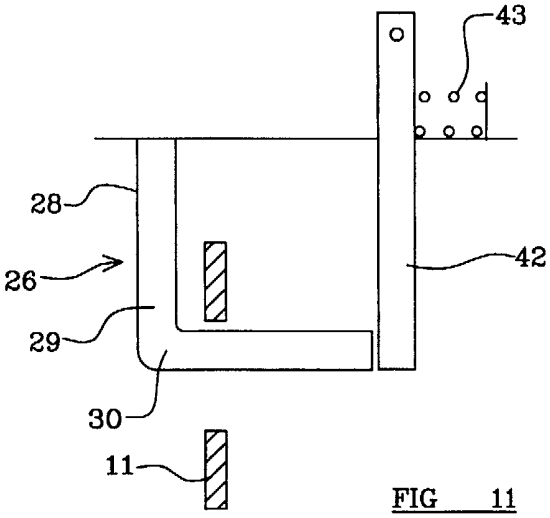


FIG 11

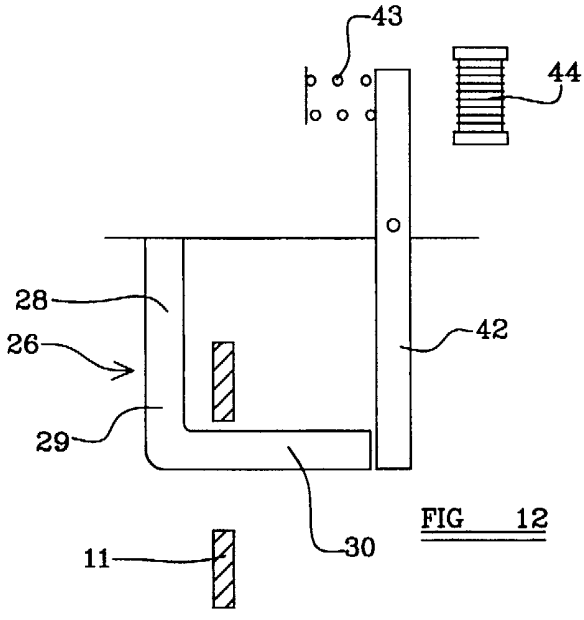


FIG 12

FIG 4

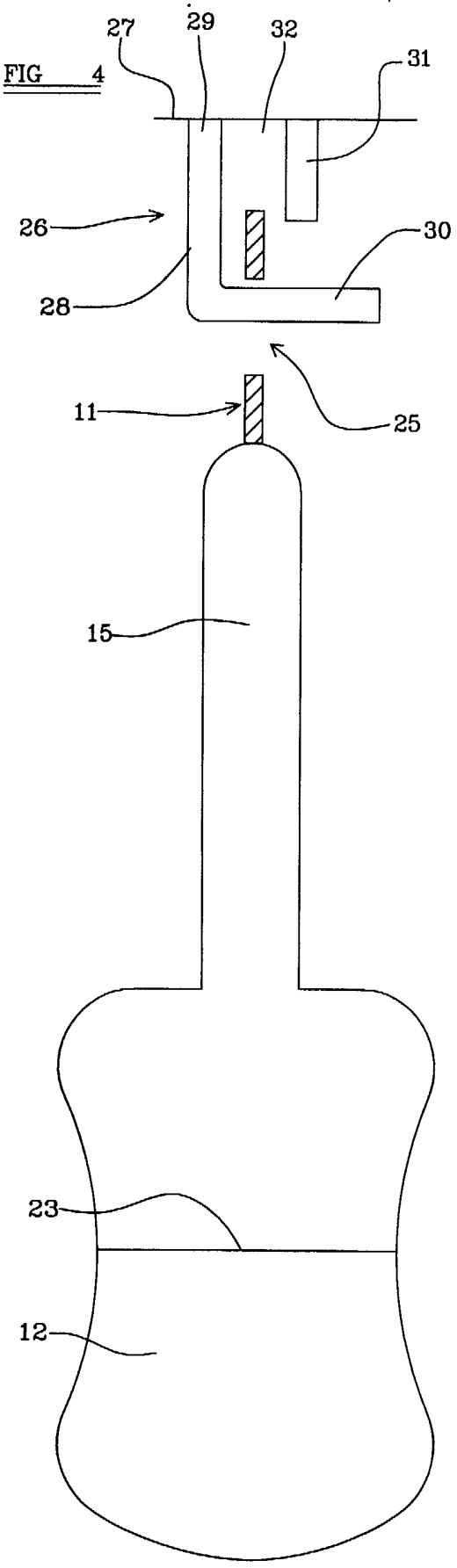
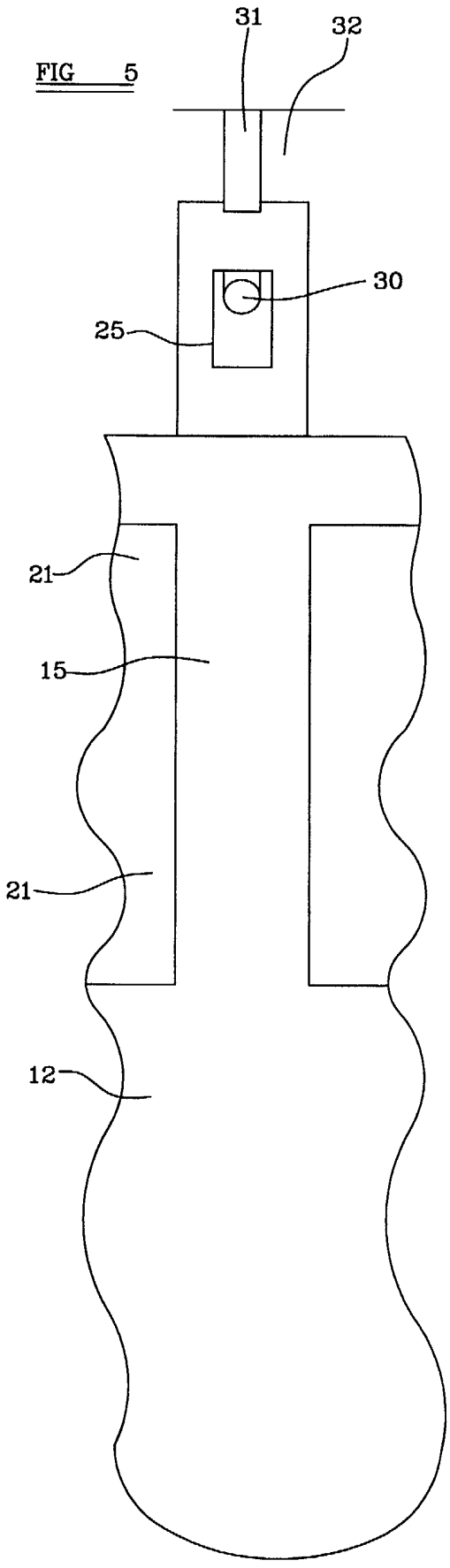


FIG 5



DESCRIPTION OF INVENTION

"IMPROVEMENTS IN OR RELATING TO AN AIR-BAG ARRANGEMENT"

THE PRESENT INVENTION relates to an air-bag arrangement, and more particularly relates to an air-bag arrangement adapted to provide protection for a rear seat passenger in a motor vehicle.

If, during a frontal impact, the rear seat of a motor vehicle is occupied, and the occupant of the rear seat is not wearing a seat-belt, the occupant of the rear seat will tend to move forwardly and strike the back-rest of the front seat. This will tend to move the back-rest of the front seat forwardly. Not only will the occupant of the rear seat stand a high risk of being injured, due to the impact with the back-rest of the front seat, but if the front seat is occupied by a person wearing a safety-belt, the occupant of the front seat may receive substantial injuries because the force applied to the back-rest of the front seat by the occupant of the rear seat moving forwardly, may serve to crush the upper torso of the occupant of the front seat against the safety-belt being worn by that front-seat occupant.

On the other hand, if the occupant of the rear seat is wearing a seat-belt, the occupant of the rear seat will be restrained during a frontal impact, but will

still tend to move forwardly to a certain extent due to the extendible nature of a typical seat-belt, or possibly due to the presence of a force-limiter or energy-absorber within the safety-belt arrangement provided for the rear seat occupant. Thus the occupant of the rear seat may still move forwardly sufficiently to strike the back-rest frame of the front seat, and again the occupant of the rear seat may be injured.

It has been proposed, therefore, to provide an air-bag initially mounted within the roof of the motor vehicle which, in an accident situation, becomes inflated to extend downwardly from the roof to be located in position between the occupant of a rear seat and the back of the front seat. The air-bag, when inflated, is still connected to the roof, and occupies a predetermined position relative to the roof.

However, problems can arise, even with such a roof-mounted air-bag. For example, in a situation where the occupant of the rear seat is wearing a safety-belt, should the roof-mounted air-bag, when inflated, not be in the correct position, there is a risk that the occupant of the rear seat will still be injured. If the air-bag is too low, having regard to the size of the rear seat occupant, the air-bag may retard the torso of the occupant of the rear seat whilst still permitting the head of the occupant of the rear seat to move forwardly. The head of the occupant may then bend forwardly in an awkward manner imparting a neck injury to the occupant of the rear seat. It might be thought that this problem could be overcome by making the air-bag to be larger, but such an apparently simple solution gives rise to further problems in that it is difficult to mount a larger bag unobtrusively within the roof of the vehicle, and if a larger bag is to be used, a larger inflator has to be provided which substantially adds to the expense. Consequently, the ideal solution is to use a relatively small bag which is in a correct position when inflated.

However, even if a relatively small air-bag is provided which, when inflated, is in the correct position to provide protection for an occupant of a rear seat who is wearing a safety-belt, such an air-bag can still generate problems should the occupant of the rear seat not be wearing a safety-belt. In a frontal impact, such an unbelted occupant of a rear seat would move forwardly due to the impact, and would tend to strike part of the inflated air-bag with his head. The torso of the occupant will move forwardly, but the head would be restrained by the air-bag. Thus the head of the rear seat occupant is decelerated, whilst the torso of the rear seat occupant moves forwardly, and again this can lead to neck injuries.

The present invention seeks to provide an improved air-bag arrangement.

According to this invention there is provided an air-bag arrangement for protecting an occupant of a seat of a motor vehicle, the air-bag arrangement comprising an inflatable element and at least one inflator to inflate the inflatable element, the air-bag being mounted to the roof of the vehicle by at least one mounting such that, when inflated, the air-bag extends downwardly from the roof of the vehicle to occupy a position in front of an occupant of a seat of the vehicle, the or each mounting being adapted to release the inflatable element in response to a force having a substantial forward component applied to the air-bag, or in response to an accident situation when a seat of the vehicle is occupied by an unbelted seat occupant.

It is envisaged that an air-bag arrangement of the invention may be practicable for use in mid-size and large size cars. In very small cars there may not be room for the air-bag arrangement.

Preferably the or each mounting is adapted so that the inflatable element remains attached to the roof if subjected to a substantially downwardly directed force, but becomes disengaged from the roof when subjected to a forwardly directed force.

Conveniently there are a plurality of mountings.

In one embodiment of the invention the air-bag is dimensioned to be located, when inflated, in front of two seat occupants, there being at least one mounting in front of each occupant. It is envisaged in such an embodiment that if one seat occupant is unbelted and moves forwardly, the or each mounting in front of that occupant will release that part of the inflatable element in front of that occupant, but if the other occupant is belted, then the air-bag in front of that other occupant will not be released.

Conveniently the air-bag is configured so that, when released, the inflated air-bag may be located substantially in front of the torso of, and above the lap of, the seat occupant.

It is envisaged that air-bag arrangements in accordance with the invention may be used primarily for protecting the occupant of a rear seat.

The invention relates to an air-bag arrangement when mounted in a motor vehicle.

Advantageously the or each mounting arrangement comprises a hook extending from the roof of the vehicle, and an apertured element provided on the air-bag received on the hook, the hook being associated with a retainer to

retain the apertured element on the hook, unless a forwardly directed force is applied to the air-bag.

Preferably the hook comprises a shank supporting a substantially horizontal arm, the apertured element being received on the horizontal arm, there being a retainer element located on or adjacent the horizontally extending arm to retain the apertured element on the horizontal arm until forwardly directed force is applied to the air-bag.

In one embodiment the retainer comprises a stop element extending downwardly from above the horizontal arm, the stop element terminating a predetermined distance above the horizontal arm.

In an alternative embodiment the retainer comprises a breakable frangible element.

In a further embodiment the retainer is a frangible element mounted on the horizontal arm.

In another embodiment the retainer is a breakable thread extending from part of the inflatable element to a fixed point.

In yet another embodiment of the invention the retainer is a pivoted retainer arm which is resiliently biased into engagement with the horizontal arm.

Preferably an electromagnetic arrangement is provided to move the retainer arm to a position in which it is disengaged from the horizontal arm.

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

FIGURE 1 is a diagrammatic view illustrating a motor vehicle provided with an overhead air-bag for protecting a rear seat occupant in a situation that might be expected to arise when the rear seat of the vehicle is occupied, and a frontal impact occurs, the rear seat occupant being restrained by a safety-belt.

FIGURE 2 is a view corresponding to Figure 1, save that in Figure 2 the rear seat occupant is not restrained by a safety-belt,

FIGURE 3 is a diagrammatic front view of one embodiment of an air-bag in accordance with the invention,

FIGURE 4 is a sectional view taken on the line A-A of Figure 3,

FIGURE 5 is a front view of the part of the air-bag shown in Figure 4,

FIGURE 6 is an enlarged view of part of Figure 4 in one condition of the air-bag,

FIGURE 7 is a view corresponding to Figure 6 illustrating a further condition of the air-bag,

FIGURE 8 is a view corresponding to Figure 7 showing yet a further condition of the air-bag,

FIGURE 9 is view corresponding to Figure 6 illustrating an alternative embodiment of the invention,

FIGURE 10 is a view corresponding to Figure 6 illustrating a further embodiment of the invention,

FIGURE 11 is a view corresponding to Figure 6 showing yet another embodiment of the invention, and

FIGURE 12 is a view corresponding to Figure 6 showing another embodiment of the invention.

Referring initially to Figure 1 of the accompanying drawings, part of a vehicle 1 is illustrated, the figure showing a front seat 2 provided within the motor vehicle, and a rear seat 3 located behind the front seat. The rear seat 3 is shown to be occupied by an occupant 4 who is restrained by a conventional rear seat safety-belt 5.

The motor vehicle 1 is provided with a roof-mounted overhead air-bag 6 which is illustrated in the deployed condition. The air-bag has inflated and dropped from the roof to be located between the occupant 4 of the rear seat and the back-rest 7 of the front seat 2. As shown in Figure 1, the air-bag is in the correct position to protect the occupant 4 of the rear seat 3, and the head of the occupant is restrained by the main inflated part of the air-bag 6. However, if the air-bag 6 were much lower than the position illustrated in Figure 1, the head of the rear seat occupant 4 could "nod" forwardly, thus impacting with the back-rest 7 of the front seat 2.

It is to be understood, therefore, that it is important that an overhead bag of the type generally illustrated in Figure 1 should be in the correct position in order to protect the occupant 4 of a rear seat 3 who is actually wearing a safety-belt 5.

Turning now to Figure 2 of the drawings, where the same reference numerals are used as in Figure 1, it is to be observed that the occupant 4 of the rear seat is not restrained by a safety-belt. Thus, in a frontal impact situation, as illustrated, the occupant tends to move forwardly. Here there is a risk that the occupant will move in such a way that the air-bag 6 engages part of the head of the seat occupant, thus forcing the head backwards as the main torso of the rear seat occupant moves forwardly. This may cause severe neck injury to the occupant of the rear seat.

In the embodiments of the invention which will be described hereinafter, a roof-mounted air-bag which is to provide protection for the occupant of a rear seat is mounted to the roof in such a way that, in a frontal impact situation, if the occupant of the rear seat is belted, the air-bag will remain connected to the roof and will adequately withstand a generally downward force applied to the air-bag by the rear seat occupant. However, if the rear seat occupant is unbelted, and moves forwardly relative to the seat, so as to apply a generally forwardly directed force to the air-bag, the air-bag will be able to be disconnected from its roof-mounting. The inflated chamber of the air-bag will then move forwardly together with the occupant of the rear seat, and will not apply any undesirable force to the neck of the rear seat occupant.

As will become clear from the following description, various techniques may be utilised to enable the disengagement of the air-bag from a roof-

mounting when an unbelted occupant of the rear seat moves forwardly in a frontal impact, whilst ensuring that the air-bag remains securely connected to the roof-mounting when the air-bag is impacted by an occupant of a rear seat who is wearing a safety-belt.

Figure 3 illustrates a typical overhead air-bag which may be utilised in embodiments of the invention. The overhead air-bag may be made of two sheets of fabric which are stitched together, or may be made using a one-piece weaving technique. The air-bag comprises a generally rectangular inflatable element 10, the upper-most edge of which is provided with mounting plates 11, which are shown schematically in Figure 3, but which will be described in greater detail hereinafter, provided at spaced-apart points along the upper edge thereof. The mounting plates 11 are to be utilised to mount the air-bag to the roof of a vehicle.

The rectangular inflatable element 10 defines, across its lower-most edge, a substantially horizontal generally cylindrical inflatable chamber 12. The inflatable chamber 12 is connected by means of gas-flow passages 13, 14, 15, 16 defined by seams of the inflatable element 10 which extend upwardly from the chamber 12 to two separate flexible tubular gas supply ducts 18, 19 which extend away from the main part of the inflatable element 10 to gas generators or inflators 20, 21. The regions 22 between the gas ducts are not capable of inflating.

It is to be appreciated that the entire air-bag, when in an initial or uninflated condition, is stored within the roof-lining of a vehicle. On inflation of the air-bag gas from the gas generators or inflators 20 and 21 flows through the gas supply ducts 18, 19, and is thus directed, through the gas flow passages 13, 14, 15, 16 to inflate the cylindrical chamber 12. Initially the gas

flow passages 13, 14, 15, 16 inflate and distend, thus extending down from the roof. The air-bag is thus moved down from the roof of the vehicle and the part of the air-bag that will form the chamber 12 is positioned a certain distance behind the ordinary location of the back-rest of a front seat, to ensure that the air-bag will achieve the desired position regardless of the adjustment of the front seat, and regardless of the angle of rake of the back-rest of the front seat. Then the chamber 12 inflates. The chamber 12 is positioned to be located in front of the torso of, and above the lap of, a rear seat occupant, and gas flow passages 13, 14, 15, 16 and the intermediate uninflated regions 22 are positioned to be located in front of the head of a rear seat occupant.

In the described embodiment, the chamber 12 is provided with internal transverse straps 23 which help ensure that the chamber 12 has an appropriate shape when inflated.

In a first embodiment of the invention, which is shown most clearly in Figures 4 and 5, the mounting plates 11 provided at the upper part of the air-bag are each in the form of an apertured metal plate, the plates thus each presenting an aperture 25. The plates are secured in an appropriate way to the upper edge of the rectangular inflatable element 10. Each apertured mounting plate 11 is mounted on a mounting 26 provided in the roof 27 of the vehicle, the mounting 26 comprising a hook element 28 having a vertical shank 29 extending downwardly from the roof 27, and a horizontally extending arm 30 extending from the lower-most end of the vertical shank 29. Located in front of the vertical shank 29 and above the arm 30 is a depending stop element 31. There is only a limited space between the lower end of the stop element 31 and the upper surface of the horizontal arm 30. As can be seen from Figure 4, the plate 11 is mounted on the hook 28 with the aperture 25 in the plate 11 receiving the horizontal arm 30. A part 32 of the plate located above the

aperture is thus located behind the stop element 31. The top-most edge of the plate 11 is above the level of the bottom of the stop element 31. The height of the aperture 25 in the plate is at least twice the diameter of the horizontal arm 30.

As seen most clearly in Figure 4, the internal straps 23 help ensure that the chamber 12 has a desirable shape when inflated. It is preferable for the chamber 12 to present a substantially flat face towards the seat occupant. This will minimise the risk of neck injuries arising if the seat occupant is only short. If a short seat occupant engaged a rounded gas chamber it is possible that his head may be moved in a way that would cause injury.

Figure 6 illustrates the mounting 26 and plate 11 in the situation that they occupy if the air-bag has been deployed but has not been struck by a seat occupant. The plate 11 is substantially vertical, and even if the plate 11 does tend to move forwardly slightly, the upper part 32 of the plate will engage the stop 31, and the mounting plate 11 provided at the top of the air-bag does not become separated from the mounting 26.

Figure 7 illustrates the situation that may exist if the air-bag is struck by a belted occupant. The force applied to the main chamber 12 of the air-bag in such a situation is mainly a downward force which serves to pull the plate 11 generally downwardly, but with a small horizontal component. The upper part 32 of the plate located above the aperture 25 is brought into firm engagement with the horizontal arm 30 of the hook 28. The force applied to the air-bag will cause the plate 11 to tilt, as shown in Figure 7. The plate 11 is retained on the hook element 28, as the upper part 32 of the plate 11 still engages the stop 31.

If the air-bag is struck by an unbelted seat occupant a very substantial horizontal force is applied to the bag. The force causes the plate 11 to tilt to a greater extent than as shown in Figure 7. Figure 8 shows the further stage of tilting of the plate 11, as is achieved when the air-bag is struck by an unbelted occupant. It will be understood that as the plate tilts, so the plate will enter a condition in which the upper edge of the plate may pass beneath the bottom of the stop element 31, and so the plate will become disengaged from the combination of the hook 28 and the stop element 31. As each of the plates 11 becomes disengaged in this way, the upper part of the air-bag in front of the unbelted occupant becomes disconnected from the roof, and the air-bag may then move forwardly relatively freely, only being retained in position by the gas supply ducts 15 and 16 which are relatively flexible.

A single air-bag may extend across the width of the vehicle, and the rear seat may be occupied by one belted occupant and one unbelted occupant. In such a situation the part of the air-bag in front of the unbelted occupant will operate as described above with reference to Figure 7, and the part in front of the belted occupant will operate as described with reference to Figure 8.

Figure 9 illustrates a modified embodiment of this invention. In this embodiment of the invention each moving is again a hook constituted by a vertical shank 29, and a horizontal arm 30, but instead of there being a depending stop 31 located above the arm 30 there is, mounted on the arm 30 a frangible upstanding pin 40. It will be appreciated that a downward force applied to the plate 11 will not bring the plate 11 into engagement with the frangible pin 40 in such a way as to break the frangible pin 40. However, a forwardly directed force applied to the plate 11 will bring part of the plate 11 into engagement with the frangible pin 40, and if the force exceeds a threshold,

the force will cause the frangible pin 40 to break, thus permitting the plate 11 to move further forwardly and become disengaged from the horizontal arm 30 of the hook 28.

Figure 10 illustrates a further embodiment of the invention in which the hook 28 of each mounting consists solely of the vertical shank 29 and the horizontal arm 30. The plate 11 is mounted on the hook in the manner described above. A breakable thread 41 extends from the plate 11 to a fixed point, such as part of the roof 27 of the motor vehicle, the breakable thread being such that if a vertical force is applied to the plate 11, the plate does not tend to move forwardly relative to the hook 28, the breakable thread does not break, and the plate 11 is retained on the hook 28. However, if a substantial forwardly directed force is applied to the plate 11, tending to move the plate 11 forwardly relative to the hook 28, the thread will break, thus permitting the plate to move to a position in which it becomes disengaged from the hook.

Figure 11 illustrates a further modified embodiment of the invention in which the plate 11 is again mounted on a hook 28 comprising a vertical shank 29, and a horizontal arm 30. Associated with the free end of the arm 30 is a pivotally mounted keeper 42 which is initially in a position in which engages the free end of the arm 30, thus preventing the plate 11 from becoming disengaged from the arm 30. The keeper 42 is initially maintained in this position by means of a spring 43. Again it will be appreciated that if a downward force is applied to the plate 11, the plate 11 will not tend to move forwardly to engage the keeper, and will be retained on the horizontal arm 30 of the hook 26. If a forwardly directed force is applied to the plate 11, the plate 11 will engage the keeper 42 and if the forwardly directed force is sufficiently great will move the keeper against the spring-bias provided by the spring 43

away from the end of the horizontal arm 30, thus enabling the plate 11 to become disengaged from the hook.

Figure 12 illustrates a further embodiment of the invention involving a keeper 42 which is spring-biased by means of a spring 43 into a position in which it serves to retain the plate 11 on the hook 28. An electro-magnet 44 is provided adapted to generate a field that will act on the keeper 42 to move the keeper 42 to the open position. The electro-magnet may be actuated, whenever the air-bag is deployed, should the occupant of a rear seat not be wearing a seat-belt. This can be determined by using a weight sensor in the seat and a buckle switch which is only closed when the tongue of the safety-belt is inserted into the buckle of the safety-belt. Thus, in the embodiment of Figure 12, the keeper would be in the position illustrated at all times unless an accident occurs and the overhead bag is deployed and, at that time, the rear seat is occupied by a person who is not wearing a safety-belt. In that specific combination of circumstances, the electro-magnet 44 would be actuated in order to move the keeper 42 pivotally to an open or release position. It will be appreciated that, in such a condition of the keeper, if the plate 11 is subjected to a force tending to move the plate forwardly, the plate will become disengaged from the hook.

While the invention has been specifically described with reference to an arrangement for a rear seat, arrangements in accordance with the invention maybe used to protect occupants of other seats within a vehicle.

In the present Specification "comprises" means "includes or consists of" and "comprising" means "including or consisting of".

The features disclosed in the foregoing description, or the following Claims, or 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 attaining the disclosed result, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

CLAIMS:

1. An air-bag arrangement for protecting an occupant of a seat of a motor vehicle, the air-bag arrangement comprising an inflatable element and at least one inflator to inflate the inflatable element, the air-bag being mounted to the roof of the vehicle by at least one mounting such that, when inflated, the air-bag extends downwardly from the roof of the vehicle to occupy a position in front of an occupant of a seat of the vehicle, the or each mounting being adapted to release the inflatable element in response to a force having a substantial forward component applied to the air-bag, or in response to an accident situation when a seat of the vehicle is occupied by an unbelted seat occupant.

2. An air-bag arrangement according to Claim 1 wherein the or each mounting is adapted so that the inflatable element remains attached to the roof if subjected to a substantially downwardly directed force, but becomes disengaged from the roof when subjected to a forwardly directed force.

3. An air-bag arrangement according to Claim 1 or Claim 2 wherein there are a plurality of mountings.

4. An air-bag arrangement according to Claim 3 wherein the air-bag is dimensioned to be located, when inflated, in front of two seat occupants, there being at least one mounting in front of each occupant.

5. An air-bag arrangement according to any one of the preceding Claims wherein the air-bag is configured so that, when released, the inflated air-bag

may be located substantially in front of the torso of and above the lap of, the seat occupant.

6. An air-bag arrangement according to any one of the preceding Claims wherein the or each mounting arrangement comprises a hook extending from the roof of the vehicle, and an apertured element provided on the air-bag received on the hook, the hook being associated with a retainer to retain the apertured element on the hook, unless a forwardly directed force is applied to the air-bag.

7. An air-bag arrangement according to Claim 6 wherein the hook comprises a shank supporting a substantially horizontal arm, the apertured element being received on the horizontal arm, there being a retainer element located on or adjacent the horizontally extending arm to retain the apertured element on the horizontal arm until forwardly directed force is applied to the air-bag.

8. An air-bag arrangement according to Claim 7 wherein the retainer comprises a stop element extending downwardly from above the horizontal arm, the stop element terminating a predetermined distance above the horizontal arm.

9. An air-bag arrangement according to Claim 7 wherein the retainer comprises a breakable frangible element.

10. An air-bag arrangement according to Claim 7 wherein the retainer is a frangible element mounted on the horizontal arm.

11. An air-bag arrangement according to Claim 7 wherein the retainer is a breakable thread extending from part of the inflatable element to a fixed point.

12. An air-bag arrangement according to Claim 7 wherein the retainer is a pivoted retainer arm which is resiliently biased into engagement with the horizontal arm.

13. An air-bag arrangement according to Claim 12 wherein an electromagnetic arrangement is provided to move the retainer arm to a position in which it is disengaged from the horizontal arm.

14. An air-bag arrangement according to any one of the preceding Claims for protecting the occupant of a rear seat.

15. An air-bag arrangement according to any one of the preceding Claims mounted in a motor vehicle.

16. An air-bag arrangement substantially as herein described with reference to and as shown in Figures 3 to 8 of the accompanying drawings.

17. An air-bag arrangement substantially as herein described with reference to and as shown in Figure 9 of the accompanying drawings.

18. An air-bag arrangement substantially as herein described with reference to and as shown in Figure 10 of the accompanying drawings.

19. An air-bag arrangement substantially as herein described with reference to and as shown in Figure 11 of the accompanying drawings.

20. An air-bag arrangement substantially as herein described with reference to and as shown in Figure 12 of the accompanying drawings.

21. Any novel feature or combination of features disclosed herein.

INVESTOR IN PEOPLE

Application No: GB 0205675.2 **Examiner:** Stephen Williams
Claims searched: 1-20 **Date of search:** 30 May 2002

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Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

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Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	GB 2345669 A (AUTOLIV) See page 3, line 22 to page 4, line 9.	1, 3, 4 & 5.

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.