Title: PEDESTRIAN PROTECTION AIRBAG SYSTEM

Abstract: A vehicle has a pedestrian protection airbag system (2) that includes an airbag (4) disposed in a folded configuration between a sound-absorbing mat (19) provided beneath the vehicle’s hood (8) and a bottom (20) of the hood (8) in a region at the rear end of the hood closest to a windshield (6) of the vehicle. The vehicle is provided with a mechanical device (10) that functions as both a hinge allowing the hood to be raised at the front of the vehicle during normal operation of the vehicle and a release allowing a region of the hood closest to the windshield to be raised. The mechanical device (10) may be two hinged joints (13, 14) with the airbag located between them. The sound-absorbing mat (19) is provided with one at least partially rolled or arched extension tab (21), which encloses at least a region of the folded airbag (4) and provides a shield or protection for the deploying airbag (4) in relation to vehicle parts in the front region (3) of the vehicle. A hard shell (22) for protecting other vehicle components in the engine compartment is provided on the sound-absorbing mat (19) in the region of the extension tab (21). The deploying airbag (4) expanding and pushing against both the bottom of the hood and the hard shell to activate the opening kinematics and lift the region of the hood nearest the windshield. The airbag in a deployed state (9) covers at least a region of the windshield (6).
PEDESTRIAN PROTECTION AIRBAG SYSTEM

A vehicle having a pedestrian protection airbag system has an airbag integrated in a front region of the vehicle.

A vehicle with a pedestrian protection airbag system is disclosed in DE 103 45 387 A1. The pedestrian protection airbag system has an airbag integrated at the rear end of a vehicle's hood. The airbag can only be deployed after a hood lifter has been actuated. The hood lifter without other assistance completely lifts the hood. The pedestrian protection airbag system completely covers the windshield with the exception of a few observation slits for the driver. An airbag of this type has the disadvantages that it limits the vision of the driver when deployed and actuation of a hood lifter is required.

JP 2004-322724 discloses a pedestrian protection airbag system wherein the rear end of a vehicle's hood is lifted by an airbag after a blocking mechanism in the form of a lock pin has been pulled out of a locking hole of an articulated arm by the airbag. This device is undesirable because the lock pin can become jammed in the locking hole such that both movement mechanisms, namely the lifting of the hood by the airbag and the removal of the lock pin from the locking hole, block each other.

The present invention provides a vehicle with a pedestrian protection airbag system having an airbag integrated in the a region of the vehicle. In a dormant state, the airbag is provided beneath a region of hood closest to a windshield. In a deployed state the airbag covers at least part of the windshield. At least one mechanical device functions as both a hinge allowing the hood to be raised at the front of the vehicle during normal operation of the vehicle and a release allowing a region of the hood closest to the windshield to be raised, which can be actuated by the deploying airbag to enable lifting of the region of the hood facing the windshield.

A vehicle with the new pedestrian protection airbag system has the advantage that a region of the hood is raised by the deploying airbag without having to actuate lifting devices or locking devices that may pose a potential
risk of failure. A simple and reliable mechanical device that functions as both a hinge allowing the hood to be raised at the front of the vehicle during normal operation of the vehicle and a release allowing a region of the hood closest to the windshield to be raised ensures that a region of the hood facing the windshield is lifted as a pressure point of this opening is overcome. The airbag upon deployment applies considerable force that is used to overcome a threshold of the mechanical device that allows the mechanical device to switch from a hinge mode to a release mode. The deployed airbag covers at least the lower cross-member of the windshield. The lifted hood and the covering of a gap between the lower cross-member of the windshield and the rear edge of the hood by the airbag ensure that an impact of a human body is cushioned.

FIG. 1 is a schematic perspective view of a vehicle having a pedestrian protection airbag system according to the invention.

FIG. 2 is a schematic bottom view of a region facing a windshield beneath a hood fixed to an airbag.

FIG. 3 is a schematic bottom view of a hood fixed to an airbag.

FIG. 4 is a schematic cross-section of pedestrian protection airbag system of a further embodiment of the invention.

FIG. 5 is a schematic cross-section of a pedestrian protection airbag system according to FIG. 4.

FIG. 6 is a schematic cross-section of a pedestrian protection airbag system that is a variant of the embodiment of FIG. 4.

FIG. 7 is a schematic perspective view of a front region of a vehicle having a deploying airbag.

FIG. 8 is a schematic partial view of FIG. 7 with the airbag deployed.

FIG. 9 is a schematic partial view of a pedestrian protection airbag system.

FIG. 1 is a schematic perspective view of a vehicle 1 equipped with a pedestrian protection airbag system 2 according to one embodiment of the invention. In FIG. 1 an airbag 4 in the front region 3 of the vehicle 1 is fully deployed. In this deployed state the the center region 29 of the airbag 4
covers a lower region 7 of the windshield 6. In a deployed state the airbag 4 further comprises lateral regions 30, 31 that partially cover at least the the base regions of the A-pillars 11, 12 disposed laterally of the windshield and partially extend over an outside rear-view mirror 26.

In the dormant state the airbag 4 is fixed to a lower side of a region of a hood 8 close to the windshield 6, where in the deployed state of the airbag 4 when a pedestrian impact or imminent impact is sensed a rear region of the hood 8 is raised by the expanding airbag 4. To this end, the vehicle in the region 7 of the hood 8 closest to the windshield 6 is provided with a mechanical device 10 that functions as both a hinge allowing the hood to be raised at the front of the vehicle during normal operation of the vehicle and a release allowing a region of the hood closest to the windshield to be raised, which comprises hinged joints 13, 14 on either side 15, 16 of the hood 8. These hinged joints ensure the capacity of lifting the hood at the front of the vehicle after releasing a preliminary locking device, without causing the mechanical device that functions as both a hinge allowing the hood to be raised at the front of the vehicle during normal operation of the vehicle and a release allowing a region of the hood closest to the windshield to be raised to switch from the hinge mode to the release mode. The pedestrian protection airbag system 2 has the capacity to bring about the lifting of the hood 8, which is shown in FIG. 1, after overcoming a threshold for changing the operational modes of the mechanical device 10 that functions as both a hinge allowing the hood to be raised at the front of the vehicle during normal operation of the vehicle and a release allowing a region of the hood closest to the windshield to be raised by the airbag 4.

The activation of the airbag in a timely manner is achieved when the vehicle is provided in a front bumper region 27 of the vehicle 1 with a proximity sensor system 28, which interacts with the corresponding trigger control of the airbag. The proximity sensor system may comprise a plurality of proximity sensors in the form of transmitting and receiving components, for example an ultrasound sensor system. Of this type are known from the prior art so that only an adjustment of the proximity sensor system to the
hazardous situation is required. Proximity sensor systems of this type may also be provided in headlights or other signal transmitters in the front region of the vehicle. Finally, it is also possible to detect the pedestrian impact caused by the impacting human body and at the latest then trigger the protection method for a pedestrian impact with the moving vehicle.

As the region 7 of the hood 8 closest to the windshield 6 is lifted by the airbag 4 a gap 40 is created between the lower cross-member and the rear edge of the hood, the gap being limited in the width by the two hinged joints 13, 14. After lowering the region of the hood closest to the windshield, the mechanical device that functions as both a hinge allowing the hood to be raised at the front of the vehicle during normal operation of the vehicle and a release allowing a region of the hood closest to the windshield to be raised returns to a hinge mode so the hood remains fully functional.

FIG. 2 is a schematic bottom view of a region 7 facing a windshield 6 beneath a hood 8 comprising an airbag 4 in a dormant state. The airbag 4 is disposed directly on the bottom 20 of the hood 8 in the region 7 facing the windshield 6. The airbag is accomodated in a space-saving manner by folding the airbag in a pleated configuration, wherein the pleated configuration provides a pleated region 23 for covering at least a portion of the windshield and a further pleated region 24, 25 having optionally a different pleated configuration for covering at least a region of at least one A-pillar and/or at least one outside rear-view mirror. The pleated regions 24, 25 at the end regions of the airbag only inflate and deploy when the pleated region 23 of the center region has already lifted the hood 8. The airbag 4 and an inflator 34 are fixed onto the bottom 20 of the hood 8 and connected to the hood via appropriate fastening means. The inflator 34 is triggered by a trigger control 33 and supplies gas to the airbag 4 to inflate and deploy the airbag. The trigger control 33 is electrically connected to the proximity sensor system shown in FIG. 1 via cables 35, 36. Upon triggering of the inflator 34 first the center pleated region 23 of the airbag for covering the windshield is inflated and subsequently, through an appropriate pleated configuration, the lateral pleated regions 24, 25 are inflated to cover at least
one of the A-pillars and an outside rear-view mirror.

FIG. 3 is a schematic bottom view of a hood 8 having an airbag 4 fixed to a lower surface of the hood 8 with the help of fastening tabs 37. The interior of the airbag is in communication with an inflator 34. The inflator 34 is activated by the trigger control 33, so that the pleated region 23 of the airbag 4 can first deploy in the center in relation to the windshield and then the pleated regions 24, 25 at the ends of the airbag 4 inflate in order to cover lateral regions of the vehicle during a pedestrian impact situation. A dash-dotted line 42 marks the boundary of a sound-absorbing mat, which is not shown and which, above the line 42, protects an assembly comprising the airbag 4 and the inflator 34 and can lift off from the bottom 20 upon activation of the airbag. Beneath the line, the sound-absorbing mat is fixed to the bottom 20 or to the bottom side panel 38 and no lifting of the sound-absorbing mat is provided for.

FIG. 4 is a schematic cross-section of a pedestrian protection airbag system 2 comprising an airbag 4 of a further embodiment of the invention. The airbag 4 is fixed to a region 7 of the hood 8 closest to the windshield to the bottom or to the bottom panel 38 of the hood 8 with the help of the fastening tabs 37. The airbag 4 is disposed in a folded configuration between a sound-absorbing mat 19 provided beneath the hood 8 and a bottom 20 of the hood. Vehicle hoods are commonly associated with such sound-absorbing mats. This arrangement has the advantage that the sound-absorbing mat protects the airbag from mechanical damage and exposure to chemicals. When the airbag is deployed the sound-absorbing mat can form a resilient, protective barrier against damage by vehicle components having sharp edges inside the engine compartment and between the engine compartment and the windshield. The sound-absorbing mat thus makes additional protective covers for the airbag redundant.

The protective action is improved by providing the sound-absorbing mat with an extension tab 21, which is at least partially rolled or arched and which encloses at least a region of the folded airbag and also acts a shield or protection for the deploying airbag in relation to vehicle parts in the front.
region of the vehicle. When deployment of the airbag begins the rolled or arched extension tab can unfold across the vehicle parts in the engine compartment and between the engine compartment and windshield such that for example the windshield wiper mechanism having sharp edges is covered. The extension tab 21 prevents the airbag from being damaged during deployment by vehicle parts in the engine compartment having sharp edges and ensures a soft pad when the airbag deploys.

FIG. 5 is a schematic cross-section of a pedestrian protection airbag that is a variant of the embodiment according to FIG. 4. Components having identical functions as in FIG. 4 are marked with the same reference numerals and will not be explained again. In this embodiment shown in FIG. 5, the extension tab 21 is enlarged by rolling such that it forms a protection element for the windshield wiper mechanism at the same time, across which the airbag 4 will extend in the activation process.

FIG. 6 is a schematic cross-section of a pedestrian protection airbag system 2 comprising an airbag 4 of a further variant of the embodiment according to FIG. 4. In this embodiment, a hard shell 22 is provided on the bottom of the sound-absorbing mat 19 in the region of the extension tab 21, the shell being connected through a material bond to the bottom 39 of the sound-absorbing mat 19. If the airbag is deployed it presses the hard shell and the sound-absorbing mat against sharp-edged vehicle parts. The hard shell forms an abutment for the airbag, which can thus safely and at a reduced pressure, which is to say more quickly, overcome the threshold for changing the operational modes of the mechanical device that functions as both a hinge allowing the hood to be raised at the front of the vehicle during normal operation of the vehicle and a release allowing a region of the hood closest to the windshield to be raised. The inflation of the center pleated region 23 if the airbag provides sufficient force to overcome the threshold for changing the operational modes of the mechanical device that functions as both a hinge allowing the hood to be raised at the front of the vehicle during normal operation of the vehicle and a release allowing a region of the hood closest to the windshield to be raised and guarantee the creation of a gap.
between the windshield and the rear edge of the hood.

Instead of a hard shell, it is possible to adapt the vehicle parts in the engine compartment to the pedestrian protection requirements such that at least one vehicle part, which could cause problems in the region beneath a region of the hood facing the windshield, such as a fluid reservoir, is configured in a reinforced manner such that this vehicle part is not substantially deformed with impaired function by the deploying airbag. The reinforced vehicle part acts as an abutment for the development of a sufficiently high threshold force for changing the operational modes of the mechanical device that functions as both a hinge allowing the hood to be raised at the front of the vehicle during normal operation of the vehicle and a release allowing a region of the hood closest to the windshield to be raised.

FIG. 7 is a schematic perspective view of a front region 3 of a vehicle 1 showing a deploying airbag 4. The pedestrian protection airbag system 2 includes a mechanical device 10 that functions as both a hinge allowing the hood to be raised at the front of the vehicle during normal operation of the vehicle and a release allowing a region of the hood closest to the windshield to be raised. In this embodiment the mechanical device 10 comprises a deformable articulated arm 18 that is deformed when a threshold pressure point is overcome allowing a region of the hood closest to the windshield to be raised by the airbag 4 and a gap 40 is created at the rear edge 41 of the hood 8, thus allowing the airbag to extend through the gap.

FIG. 8 is a schematic partial view of FIG. 7 after the airbag 4 has fully deployed. A hinged joint 13, 14 may comprise at least one detent joint 17, comprising a detent the hinged joint that mates with a complementary indentation. The detent joint 17 defines the threshold of the force required for the mechanical device that functions as both a hinge allowing the hood to be raised at the front of the vehicle during normal operation of the vehicle and a release allowing a region of the hood closest to the windshield to be raised to transition from a hinge mode to a release mode. This threshold may optionally be adjustable. After the threshold pressure point of the detent joint 17 has been overcome, the hinged joint facilitates the raising of
the section of the hood closest to the windshield and delimits a gap 40 through which the airbag can deploy in the direction of the windshield. Instead of a detent hinge or in addition to the detent hinge, a hinged joint 13, 14 may comprise a deformable articulated arm 18. The deformable articulated arm 18 enables a limited raising of the section of the hood closest to the windshield and both facilitates and limits the gap 40 for deploying the inflating airbag. The mechanical device 10 that functions as both a hinge allowing the hood to be raised at the front of the vehicle during normal operation of the vehicle and a release allowing a region of the hood closest to the windshield to be raised comprises a detent hinge 17, which interacts with a deformable articulated arm 18.

In a further preferred embodiment, instead of or in addition to the detent hinge or the deformable articulated arm, at least one resilient articulated arm may be provided. A resilient articulated arm preferably comprises a rubber elastic articulated arm or a spring elastic articulated arm. Both embodiments ensure that through the pressure of the deploying airbag the resilient articulated arms enable the creation of a gap through which the airbag can deploy towards the windshield.

FIG. 9 is a schematic partial view of a pedestrian protection airbag system 2 having a fully deployed airbag 4 and a mechanical device that functions as both a hinge allowing the hood to be raised at the front of the vehicle during normal operation of the vehicle and a release allowing a region of the hood closest to the windshield to be raised, which a movable hinged joint 14, which after overcoming a threshold force for changing the operational modes of the mechanical device 10 switches to a release mode allowing a region of the hood closest to the windshield to be raised creating a gap 40 for deployment of the airbag 4. At the same time, the mechanical device 10 delimits the gap 40. The hood remains connected to the vehicle in an articulated manner.

A method for providing protection during a pedestrian impact with a front portion of moving vehicle comprises the following steps. First, a pedestrian impact is detected in the front region of the moving vehicle. Then
an inflating process is triggered for a folded airbag fixed under the vehicle's hood. During deployment of the airbag an extension tab of a sound-absorbing mat is pressed against vehicle parts by the inflating airbag. As a result of force exerted by the inflating airbag the threshold for changing the operational modes of the mechanical device that functions as both a hinge allowing the hood to be raised at the front of the vehicle during normal operation of the vehicle and a release allowing a region of the hood closest to the windshield to be raised is passed and the mechanical device transitions from the hinge mode to the release mode. Thereupon, at least a center region of the airbag deploys to offer pedestrian impact protection in the region of the windshield. In addition deployment of at least one lateral region of the airbag can occur to offer pedestrian impact protection in the region of at least one A-pillar and/or at least one rear-view mirror.

This method has the advantage that the airbag is deployed without having to previously actuate or unlock a hood lifting device or a locking device. The mechanical device that functions as both a hinge allowing the hood to be raised at the front of the vehicle during normal operation of the vehicle and a release allowing a region of the hood closest to the windshield to be raised is automatically transitioned from the hinge mode to the release mode by the inflating airbag without risking blockage of a hood locking device and without risking a delay by the hood lifting device.
Claims

1. A vehicle comprising pedestrian protection airbag system (2), the vehicle having a hood (8) that is normally lifted at the front of the vehicle, wherein the pedestrian protection airbag system (2) includes an airbag (4) that is disposed in a folded configuration between a sound-absorbing mat (19) provided beneath the hood (8) and a bottom (20) of the hood (8) in a region of the hood closest to a windshield (6) of the vehicle, the vehicle is provided with a mechanical device (10) that functions as both a hinge allowing the hood to be raised at the front of the vehicle during normal operation of the vehicle and a release allowing a region of the hood closest to the windshield to be raised, the mechanical device (10) comprising two hinged joints (13, 14) with the airbag located between them, the sound-absorbing mat (19) is provided with one at least partially rolled or arched extension tab (21), which encloses at least a region of the folded airbag (4) and provides a shield or protection for the deploying airbag (4) in relation to vehicle parts in the front region (3) of the vehicle, wherein a hard shell (22) is provided on the sound-absorbing mat (19) in the region of the extension tab (21), the shell comprising a support or protection for other components of the vehicle, the deploying airbag (4) expanding and pushing against both the bottom of the hood and the shell to exceed the threshold force required to cause the mechanical device (10) to switch to a release mode and lift the region of the hood nearest the windshield, the airbag in a deployed state (9) covering at least a region of the windshield (6).

2. A vehicle according to claim 1, wherein the airbag in the deployed state (9) covers at least a region of at least one A-pillar (11, 12), which is disposed laterally of the windshield (6).
3. A vehicle according to either of claims 1 or 2, wherein at least one hinged joint (13, 14) comprises a detent joint (17) and pressure exerted by the expanding airbag overcomes the pressure point of the detent to allows the pressure exerted by the expanding airbag (4) to lift at least a region of the hood (8).

4. A vehicle according to either of claims 1 or 2, wherein at least one hinged joint (13, 14) comprises at least one deformable articulated arm (18) and pressure exerted by the expanding airbag causes the deformable articulated arm to give way and allows the pressure exerted by the expanding airbag (4) to lift at least a region of the hood (8).

5. A vehicle according to either of claims 1 or 2, wherein at least the hinged joint (13, 14) comprises at least one resilient articulated arm (18) and pressure exerted by the expanding airbag causes the resilient articulated arm to give way and allows the pressure exerted by the expanding airbag (4) to lift at least a region of the hood (8).

6. A vehicle according to either of claims 1 or 2, wherein at least the hinged joint (13, 14) comprises at least one rubber elastic articulated arm (18) and pressure exerted by the expanding airbag causes the rubber elastic articulated arm to elastically deform and allows the pressure exerted by the expanding airbag (4) to lift at least a region of the hood (8).

7. A vehicle according to either of claims 1 or 2, wherein at least the hinged joint (13, 14) comprises at least one spring elastic articulated arm (18) and pressure exerted by the expanding airbag causes the rubber elastic articulated arm to elastically deform and allows the pressure exerted by the expanding airbag (4) to lift at least a region of the hood (8).
8. A vehicle according to any one of the preceding claims, wherein at least one vehicle part in the region beneath a region (7) of the hood (8) facing the windshield (6), particularly the fluid reservoir, is configured in a reinforced manner such that this vehicle part is not substantially deformed by the deployed airbag (4).

9. A vehicle according to any one of the preceding claims, wherein the airbag (4) is folded in a pleated configuration, which comprises a pleated region (23) for covering at least a region of the windshield and at least one pleated region (24, 25) for covering at least a region of at least one A-pillar (11, 12) and/or at least one outside rear-view mirror (26).

10. A vehicle according to any one of the preceding claims, wherein the vehicle (1) in a front bumper region (27) is provided with a proximity sensor system (28), which interacts with a trigger control (33) of the airbag (4).
A. CLASSIFICATION OF SUBJECT MATTER

B60R 21/34(2006.01)

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 8  B60R 21/34, B60R 21/00

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

Korean Utility Models and applications for Utility Models since 1975
Japanese Utility Models and applications for Utility Models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKIPASS (KIPO internal) "hood", "hinge", "airbag", "pedestrian"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Date of the actual completion of the international search
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