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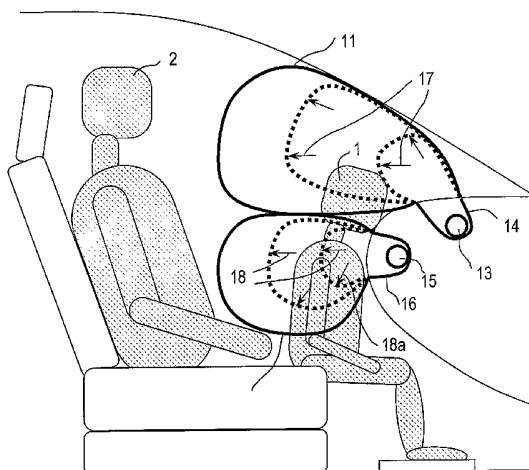
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(54) Title: LOW RISK DEPLOYMENT PASSENGER AIRBAG SYSTEM



(57) Abstract: A low risk deployment passenger airbag system has two separate airbags, a top-mounted airbag 11 and a mid-mounted airbag 12. The top-mounted airbag 11 deploys into the adult occupant's head and upper torso areas without generating substantial downward deployment, while the mid-mounted airbag 12 deploys into the adult occupant's lower torso area without generating substantial upward deployment. This mode of substantially horizontal deployments can provide an out-of-position child with a safe mode of airbag inflation, reducing the risk of neck injuries. An infant in a rear facing child seat receives distributed small forces from two airbags with a possible time delay in initial airbag contact rather than a concentrated large force from the conventional single passenger airbag. The total capacity of the two airbags is about the same as the conventional single passenger airbag and thus can provide as effective protection. The top-mounted airbag 11 has a larger capacity in volume than the mid-mounted airbag 12 and serves as a main airbag for protecting in-position occupants. The mid-mounted airbag may be deployed at low output or no output level for belted occupants during high-speed crashes, which in turn can help reduce the injury values of an infant dummy in a rear facing child seat during the low risk deployment test.

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LOW RISK DEPLOYMENT PASSENGER AIRBAG SYSTEM

REFERENCE TO RELATED APPLICATIONS

This application claims priority from U.S. Patent Application Serial Number 10/909,581 filed August 2, 2004, U.S. Provisional Patent Application Serial Nos. 60/577,569, filed June 7, 2004; 60/581,919, filed June 22, 2004, and 60/628,434 filed November 15, 2004, the entire
5 contents of the above-referenced applications are incorporated herein by reference.

FIELD OF THE INVENTION

This invention relates to a passenger airbag system for use with a motor vehicle. More specifically, two airbags are mounted separately in the instrument panel in such a way as to minimize the risk of injuries caused by airbag inflation to out-of-position occupants while
10 maintaining as effective protection for in-position occupants during serious crashes as a conventional single airbag.

BACKGROUND OF THE INVENTION

Front driver and passenger airbags have saved numerous lives and reduced injuries from severe frontal crashes. These airbags have been proven to work effectively on the roads for both
15 belted and unbelted occupants, even though they are supplementary devices to safety belts. They are designed to absorb kinetic energy during crashes in such a way that the occupant decelerates smoothly by cushioning from the inflated airbags.

In order for the airbags to protect the occupants properly, the airbags should be fully inflated fast enough to be in position in front of the occupants during the crash. However, this
20 fast inflation sometimes causes serious injuries to the occupants, especially to out-of-position occupants. For example, the occupant can move forward and get very close to the airbag during emergency braking before the crash, and then can be injured or killed by the fast-inflating airbag. Infants riding in a rear facing child seat (RFCS), children, and small size adults are more vulnerable to the risks.

25 The National Highway Traffic Safety Administration (NHTSA), a government agency, has proposed a rulemaking that sets a new performance requirement and test procedures for

advanced airbag systems. The intent of this rulemaking is to minimize risks caused by air bags to out-of-position occupants, especially infants and children, and also to improve occupant protection provided by airbags for belted and unbelted occupants of all sizes. The new rule for advanced airbags applies to about 20 percent of 2004 model year vehicles and all applicable vehicles of 2007 model year and afterward.

The advanced airbag rule, in part, requires as an option to conduct low risk deployment (LRD) airbag tests with a 12-month-old infant dummy in a rear facing child seat, and dummies representing 3 and 6 year old children. If the dummies from the airbag deployment tests do not meet the injury criteria limits set by NHTSA, vehicle manufacturers can choose another option of suppressing the airbag when infants or children are present. This airbag suppression option, however, may not provide the benefits of airbag protection for infants and children. An occupant classification sensing system is currently used in order to detect the presence of infants and children, and thus suppress the airbag accordingly. However, this occupant classification sensing system not only adds cost to a vehicle, but can also lead to reliability problems.

There have been a number of prior art attempts to reduce the injuries caused by airbag inflation to a level that can meet the low risk deployment option. The prior art attempts have employed multiple chambers in a single airbag, a bag inside another bag, different ways of airbag deployment, different ways of airbag folding, different power splits between two chambers in a dual chamber inflator, etc. To date, however, none of these technologies has proven to work reliably enough to reduce the injuries of small children and infants in rear facing child seats to a level that can meet the injury criteria of the low risk deployment option while also protecting in-position adults during serious crashes. The neck, among an occupant's body parts, is especially vulnerable to serious injuries exceeding the injury criteria limits set by the regulation.

SUMMARY OF THE INVENTION

The objectives of the present invention are therefore 1) to develop a front passenger airbag system that can minimize the risks of injuries caused by airbags to out-of-position infants and children to a level that can meet the stringent government regulation of the low risk deployment option, and 2) to improve the protection of occupants of all sizes during both low and high-speed crashes.

According to one aspect of the invention, a passenger airbag system is provided for an automotive vehicle having a passenger compartment, a windshield, and an instrument panel disposed between the passenger compartment and windshield. The passenger airbag system includes a top-mounted airbag and a mid-mounted airbag. Both airbags are deployable through the instrument panel along a predetermined path for direct contact with an occupant seated in the passenger compartment. The predetermined path is substantially horizontal.

According to another aspect of the invention, the top-mounted airbag after deployment has a volume substantially larger than the mid-mounted airbag.

According to another aspect of the invention, the top-mounted airbag after deployment is presented between a top surface of the instrument panel, the windshield and the mid-mounted airbag for direct contact with the occupant.

According to another aspect of the invention, the mid-mounted airbag after deployment is presented below the top-mounted airbag for direct contact with the occupant.

According to another aspect of the invention, a passenger airbag system is provided for an automotive vehicle having a passenger compartment, a windshield, and an instrument panel disposed between the passenger compartment and windshield. The passenger airbag system includes a top-mounted airbag and a mid-mounted airbag. Both of the airbags are deployable through the instrument panel for direct contact with an occupant seated in the passenger compartment. The deployment of at least one of the airbags during high speed crashes is controlled in accordance with an algorithm that defines a predetermined lower output level for the deployment of the at least one of the airbags when it is determined that the occupant is restrained by a safety belt in the occupant compartment.

BRIEF DESCRIPTION OF THE DRAWINGS

Advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

Fig. 1 is a side elevational view of a conventional top-mounted passenger airbag with an out-of-position child dummy and an in-position adult male dummy;

Fig. 2 is a side elevational view of a conventional mid-mounted passenger airbag with an out-of-position child dummy and an in-position adult male dummy;

Fig. 3 is a side elevational view of one embodiment of the present invention shown with an out-of-position child dummy and an in-position adult male dummy;

5 Fig. 4 is a side elevational view of an embodiment of the present invention with an infant dummy seated in a rear facing child seat during a standard low risk deployment test;

Fig. 5 is a cross sectional view of a preferred embodiment of the present invention having two separate airbag modules;

10 Fig. 6 illustrates an airbag deployment algorithm that can be used to control the mid-mounted airbag output for belted occupants during high-speed crashes;

Fig. 7 is a cross sectional view of another embodiment of the present invention in which two airbag cushions share one inflator;

15 Fig. 8 is a side view of yet another embodiment of the present invention in which the airbag housing extends from the conventional top-mounted airbag location to the conventional mid-mounted airbag location;

Fig. 9 is a perspective view of a diffuser for use with the embodiment of Fig 8, having varying sizes of opening holes;

Fig. 10 is an perspective view of a diffuser for use with the embodiment of Fig 8, having varying densities of opening holes; and

20 Fig. 11 is a side view of a deployment mode of the present invention shown with an out-of-position child dummy and an in-position adult male dummy;

DETAILED DESCRIPTION OF THE DRAWINGS

25 Referring to Figure 1, a conventional single passenger airbag module is shown top-mounted in the instrument panel. The airbag cushion 3 deploys toward the head and torso areas of an adult occupant 2. During the airbag deployment, shown as a dotted line, the airbag can generate a substantially large component of downward deployment, as indicated by the arrows

at 6. The component of downward deployment 6 can now push down the head of the out-of-position child 1 and potentially cause a serious injury to the neck. The airbag module has a gas generating inflator 4, and a housing 5 that holds the inflator 4 and airbag cushion 3.

Figure 2 shows another conventional single passenger airbag module that is mid-mounted in the instrument panel. The airbag module includes an airbag cushion 7, which
5 deploys toward the head and torso areas of an adult occupant 2. During the airbag deployment, shown as a dotted line, the airbag 7 can generate a substantially large component of upward deployment, as indicated by the arrow 10, and can be trapped under the chin of an out-of-position child 1. The component of upward deployment 10 can now push up the chin and
10 potentially cause a serious injury to the neck. The airbag module also includes a gas generating inflator 8, and a housing 9 that holds the inflator 8 and the airbag cushion 7.

Figure 3 discloses a preferred embodiment of the present inventive airbag system as utilized on the passenger side of the vehicle. The airbag system includes a top-mounted airbag 11, which is mounted behind a generally horizontal top surface of the instrument panel. The
15 top-mounted airbag 11 deploys toward the head and upper torso area of an adult occupant 2. Initially, the top-mounted airbag 11 deploys obliquely upward toward and along the windshield. When the top-mounted airbag 11 expands further, its progress toward the head and neck region of the out-of-position child 1 is substantially horizontal, as indicated by arrow 17, and thus does not generate a component of substantial downward deployment, unlike the single, conventional,
20 top-mounted airbag 3 in Figure 1, which reduces the risks of neck injuries.

The airbag system also includes a mid-mounted airbag 12, which is mounted behind a generally upright, occupant-facing surface of the instrument panel. The mid-mounted airbag 12 deploys toward the lower torso area of the adult occupant 2. The mid-mounted airbag 12 deploys generally horizontally, as indicated by the arrow 18, and downwardly, as indicated by
25 the arrow 18a, and thus does not generate a component of substantial upward deployment, unlike the single, conventional, mid-mounted airbag 7 in Figure 2, reducing the risks of neck injuries. Together, the mode of the horizontal deployments of the top-mounted airbag 11 and the mid-mounted airbag 12 can provide the out-of-position child with a safer mode of airbag deployment.

30 The sizes of both airbags 11, 12 of the present inventive airbag system are substantially smaller than the size of the conventional single passenger airbag 3 or 7. This helps distribute

impact forces to the out-of-position child during airbag inflations. Preferably, the top-mounted airbag cushion 11 is substantially larger than the mid-mounted airbag cushion 12 in volume when fully deployed since the top-mounted airbag is less aggressive than the mid-mounted airbag due to a fact that the top-mounted airbag is located further away from the out-of-position occupant. The top-mounted airbag cushion 11 could have a deployed volume ranging between 5 60 and 120 liters, while the mid-mounted airbag cushion 12 could have a deployed volume ranging between 30 and 70 liters. In some embodiments, the top-mounted air bag has a volume at least 25 percent greater than the volume of the mid-mounted airbag. In other embodiments, the volume of the top-mounted air bag may be at least 50 percent greater than the volume of the 10 mid-mounted airbag. In yet further embodiments, the top-mounted airbag may have a volume that is at least 75 or 100 percent greater than the volume of the mid-mounted airbag.

In use, the top-mounted 11 and mid-mounted 12 airbags are inflated by separate gas generating inflators 13 and 15, respectively. The inflators 13, 15 can be of any suitable type known in the art. In response to an existence of a predetermined set of factors, the inflators 13, 15 are triggered to inflate the airbags 11, 12 independently to each other. 15

In Figure 4, the deployments of the top-mounted 11 and mid-mounted 12 airbags of Figure 3 are now shown with an infant 19 in a rear facing child seat 20 belted conventionally to the vehicle seat. The top-mounted airbag cushion 11 deploys toward the head area of the child seat 20, while the mid-mounted airbag cushion 12 deploys toward the thoracic region of the 20 child seat 20.

As shown in Figure 4, the airbags 11, 12 can be inflated to contact the child seat 20 in a slightly sequential manner. To ensure the desired relative timing between the airbags 11, 12 and the child seat 20, it may be necessary to offset the firing of the inflators 13, 15. Whether to offset the firing of the inflators 13, 15 will largely depend on such factors as: the size and type 25 of inflators, size and material of each of the airbags, relative fore and aft position of the airbags, and the design and material of the airbag doors and/or tear seams.

Since the impact is now distributed into multiple parts of the child seat 20 with a possible time delay, the peak injury values of the infant in the child seat 20 can be reduced from those of conventional single airbag systems known in the art.

30 Figure 5 shows a preferred embodiment of the present invention, wherein each airbag module has a separate inflator 13, 15. The parts of the top-mounted airbag module, such as the

inflator 13, housing 14, and cushion 11 are smaller than those of top-mounted conventional single airbag, as shown in Figure 1. Similarly, the parts of the mid-mounted airbag module, such as the inflator 15, housing 16, and cushion 12, are smaller than those of the mid-mounted conventional single airbag, as shown in Figure 2. The airbag modules can have diffusers 21, 22
5 to control the output from the inflators 13, 15 into the respective airbag cushions 11, 12. It is preferable that the two airbags 11, 12 are controlled separately in regards to the firing time and the output level of the inflators 13, 15.

Figure 6 shows a flow chart of an optional airbag deployment algorithm for the preferred embodiment shown in Figure 5. The mid-mounted airbag may be deployed at low output or may
10 not be deployed at all for belted occupants during high-speed crashes including a 40 mph flat frontal rigid barrier test since the safety belt can be effective enough to restrain the occupant's torso and pelvis. This reduced inflation output to the mid-mounted airbag 12 can help reduce injury values of an infant dummy in a rear facing child seat during the low risk deployment test.

Figure 7 shows another embodiment of the present invention, wherein one inflator 23
15 generates gas to inflate both the top-mounted 11 and mid-mounted airbags 12. The inflator 23 is disposed within a single conduit 24 that is in fluid communication with both airbags 11, 12. More specifically, the conduit 24 includes an upper portion coupled to the top-mounted airbag 11 and a lower portion coupled to the mid-mounted airbag 12. Preferably, the inflator 23 is positioned between the upper 25 and the lower 26 portions of the conduit 24. It should be
20 appreciated that the inflator 23 can also be positioned at either end of the conduit 24, while remaining in fluid communication with both airbags 11, 12. Further, diffusers 21, 22 or different opening sizes of passages can be utilized between the inflator 23 and the airbags 11, 12 at any suitable point along the conduit 24 to control the amount and rate at which gas is supplied to each airbag 11, 12.

Figure 8 shows yet another embodiment of the present invention. The passenger airbag
25 system 30 includes a gas generating inflator 32, a diffuser 34 that controls the flow of the generated gas, an airbag cushion 36, and a housing 38 that contains the airbag cushion. In the present invention, the housing 38 extends from a top portion 42 of the instrument panel 40 to a mid or front portion 44 of the instrument panel as a single unit. The airbag cushion 36 may be
30 covered by an instrument panel skin 46. The length of the housing 38 of the present invention measured in the vehicle's longitudinal direction is substantially larger than the conventional

airbag housing. It is large enough to cover a substantial amount of both the top and the mid portions of the instrument panel. The length may be at least twice as large as that of conventional airbag housings in order to cover the location of a conventional top-mounted airbag and the location of a conventional mid-mounted airbag. As used herein, the top of the instrument panel means the portion of the instrument panel with a surface that is generally more horizontal than vertical and generally faces the windshield. The mid or front portion of the instrument panel is the portion with a surface that is generally more vertical than horizontal and generally faces the occupant.

Even though the width of the airbag housing 38 of this embodiment of the present invention is preferred to remain about the same as for a conventional airbag housing, it can be enlarged from the conventional size in order to further distribute the airbag cushion over the instrument panel. For a given width, the depth measured in a perpendicular direction to the instrument panel surface should decrease as the length increases in order to keep the housing volume the same. The airbag cushion, when fully deployed, preferably has about the same shape and volume as the conventional top-mounted airbag cushion.

The inflator 32 can be located anywhere within the airbag module, though the center is a preferred location, as shown in Fig. 8. Because of the long housing, the gas generated from the inflator may build up higher pressure near the inflator and lower pressure away from the inflator, which can generate undesirable cushion deployment. In order to avoid this problem, the diffuser 34 for this embodiment of the present invention can have varying sizes of opening areas to control the way the airbag cushion is deployed. The amount of opening area can be varied along the longitudinal direction as shown in Fig. 9 and Fig. 10, as an example, in order to induce uniform and radial cushion deployment in a controlled way. The opening area is made gradually larger as it goes farther away from the inflator. The opening area can be varied either by changing the hole size, as shown in Fig. 9, or by changing the hole density (the number of holes per unit area), if the hole size is kept the same, as shown in Fig. 10, or by the combination of both approaches.

The size and pattern of the opening holes can be further varied in order to fine-tune the cushion deployment. For example, it may be desirable to deploy the top portion of the airbag cushion faster than the bottom portion while maintaining the radial deployment because the top portion has farther to travel before it reaches the final shape of the cushion deployment. This

effect can also distribute the airbag aggressiveness more evenly between the top portion and the bottom portion of the cushion deployment. The top portion of the cushion is generally safer than the bottom portion (mid or front portion of the instrument panel) due to the fact that it is located farther away from the out-of-position occupants. In order to achieve the different deployment speeds, the opening area can be further enlarged toward the top end of the airbag cushion in addition to the varying sizes and/or densities away from the inflator as shown in Fig. 9 and Fig. 10.

The uniform and radial cushion deployment as shown in Fig. 11 can give two major benefits to out-of-position occupants. First, it provides a distributed force throughout the occupant body rather than a concentrated force that can be seen in conventional airbags, as shown in Fig. 1 and Fig. 2. The distributed force can lower the risk of injuries to out-of-position children and infants in child restraints. Second, the deployment mode is radial from the side view, approximately following the contour of the instrument panel. This radial deployment can reduce the risk of neck injuries significantly. In contrast, the deployment of conventional airbags has a substantial amount of risky downward or upward components near the neck area, as indicated by arrows in Fig. 1 and Fig. 2.

As will be clear to those of skill in the art, the herein described embodiments of the present invention may be altered in various ways without departing from the scope or teaching of the present invention. For example, an airbag system may be constructed with more than the two airbag modules described herein. As one example, a system with three airbag modules could be provided, each intended to follow along a generally common path to make direct contact with the occupant without substantial undesired upward or downward components of deployment. Also, while the airbag modules are shown as providing an upper or top-mounted airbag and a lower or mid-mounted airbag, two or more individual airbags may also be provided side-by-side in a transverse manner along the instrument panel, or at other angles therealong. Other variations will be clear to those of skill in the art. As such, the present disclosure should be interpreted broadly.

We claim:

1. A passenger airbag system for an automotive vehicle having a passenger
2 compartment, a windshield, and an instrument panel disposed between the passenger
compartment and windshield, the passenger airbag system comprising:
4 a top-mounted airbag and a mid-mounted airbag, both airbags being deployable through
the instrument panel along a predetermined path for direct contact with an occupant seated in
6 the passenger compartment, the predetermined path being substantially horizontal.
2. A passenger airbag system as set forth in claim 1, wherein the top-mounted
2 airbag deploys both obliquely along the windshield and horizontally toward the occupant, the
deployment substantially lacking a downward directional component relative to the occupant.
3. A passenger airbag system as set forth in claim 1, wherein the mid-mounted
2 airbag deploys both along a horizontal and a downward path toward the occupant, the
deployment substantially lacking an upward directional component relative to the occupant.
4
4. A passenger airbag system as set forth in claim 1, wherein the top-mounted
2 airbag after deployment is presented between a top surface of the instrument panel, the
windshield and the mid-mounted airbag for direct contact with the occupant.
5. A passenger airbag system as set forth in claim 4, wherein the mid-mounted
2 airbag after deployment is presented below the top-mounted airbag for direct contact with the
occupant.
6. A passenger airbag system as set forth in claim 1, wherein the top-mounted
2 airbag after deployment has a volume substantially larger than that of the mid-mounted airbag.
7. A passenger airbag system as set forth in claim 6, wherein the top-mounted
2 airbag after deployment has a volume at least 25 percent greater than the volume of the mid-
mounted airbag after deployment.

8. A passenger airbag system as set forth in claim 6, wherein the top-mounted
2 airbag after deployment has a volume at least 50 percent greater than the volume of the mid-
mounted airbag after deployment.

9. A passenger airbag system as set forth in claim 6, wherein the top-mounted
2 airbag after deployment has a volume ranging between 60 and 120 liters.

10. A passenger airbag system as set forth in claim 6, wherein the mid-mounted
2 airbag after deployment has a volume ranging between 30 and 70 liters.

11. A passenger airbag system as set forth in claim 1, wherein at least one inflator
2 generates gas for deploying the top-mounted airbag and the mid-mounted airbag along the
horizontal path.

12. A passenger airbag system as set forth in claim 11, wherein the at least one
2 inflator is disposed in a single conduit in fluid communication with both the top-mounted and
mid-mounted airbags.

13. A passenger airbag system as set forth in claim 12, wherein the single conduit
2 includes an upper portion coupled with the top-mounted airbag and a lower portion coupled
with the mid-mounted airbag, the at least one inflator being positioned between the upper and
4 lower portions of the single conduit for inflating the top-mounted and mid-mounted airbags.

14. A passenger airbag system as set forth in claim 12, wherein the single conduit
2 includes at least one diffuser for controlling the distribution of gases from the inflator between
each of the top-mounted and mid-mounted airbags.

15. A passenger airbag system as set forth in claim 12, wherein the opening sizes of
2 the upper and lower portions of the single conduit are different for controlling the distribution of
gases from the inflator between each of the top-mounted and mid-mounted airbags.

16. A passenger airbag system as set forth in claim 1, wherein two inflators each
2 inflate respective top-mounted and mid-mounted airbags.

17. A passenger airbag system as set forth in claim 16, wherein the firing times of
2 the top-mounted airbag and the mid-mounted airbag are different in order to give sequential
impacts into a rear facing child seat with a time delay.

18. A passenger airbag system as set forth in claim 16, wherein the mid-mounted
2 airbag is deployed at a predetermined lower output level for any high speed crashes when it is
determined that the occupant is restrained by a safety belt in the occupant compartment.

19. A passenger airbag system for an automotive vehicle having a passenger
2 compartment, a windshield, and an instrument panel disposed between the passenger
compartment and windshield, the passenger airbag system comprising:

4 a top-mounted airbag and a mid-mounted airbag, both airbags being deployable through
the instrument panel for direct contact with an occupant seated in the passenger compartment,
6 the top-mounted airbag having a volume after deployment that is substantially larger than the
volume of the mid-mounted airbag after deployment.

20. A passenger airbag system as set forth in claim 19, wherein the top-mounted
2 airbag after deployment has a volume at least 25 percent greater than the volume of the mid-
mounted airbag after deployment.

21. A passenger airbag system as set forth in claim 19, wherein the top-mounted
2 airbag after deployment has a volume at least 50 percent greater than the volume of the mid-
mounted airbag after deployment.

22. A passenger airbag system as set forth in claim 19, wherein both airbags are
2 deployable along a common predetermined path that is substantially horizontal.

23. A passenger airbag system as set forth in claim 22, wherein the top-mounted
2 airbag deploys both obliquely along the windshield and horizontally toward the occupant, the
deployment substantially lacking a downward directional component relative to the occupant.

24. A passenger airbag system as set forth in claim 22, wherein the mid-mounted
2 airbag deploys both along a horizontal and a downward path toward the occupant, the
deployment substantially lacking an upward directional component relative to the occupant.

4

25. A passenger airbag system as set forth in claim 19, wherein two inflators each
2 inflate respective top-mounted and mid-mounted airbags.

26. A passenger airbag system as set forth in claim 25, wherein the mid-mounted
2 airbag is deployed at a predetermined lower output level for any high speed crashes when it is
determined that the occupant is restrained by a safety belt in the occupant compartment.

27. A passenger airbag system for an automotive vehicle having a passenger
2 compartment, a windshield, and an instrument panel disposed between the passenger
compartment and windshield, the passenger airbag system comprising:

4 an upper airbag and a lower airbag, both being deployable through the instrument panel
for direct contact with an occupant seated in the passenger compartment, the deployment of at
6 least one of the airbags during high speed crashes being controlled in accordance with an
algorithm that defines a predetermined lower output level for the deployment of the at least one
8 of the airbags when it is determined that the occupant is restrained by a safety belt in the
occupant compartment.

28. A passenger airbag system as set forth in claim 27, wherein the upper airbag is
2 top-mounted and the lower airbag is mid-mounted.

29. A passenger airbag system as set forth in claim 27, wherein the high speed
2 crashes includes 64 km/h (40 mph) flat frontal rigid barrier tests.

30. A passenger airbag system as set forth in claim 27, wherein the lower airbag is
2 deployed at a predetermined low output level and the upper airbag is deployed at a
predetermined high output level when it is determined that the occupant is restrained by a safety
4 belt in the occupant compartment.

31. A passenger airbag system as set forth in claim 27, wherein the lower airbag is
2 not deployed at all and the upper airbag is deployed at a predetermined high output level when
it is determined that the occupant is restrained by a safety belt in the occupant compartment.
4

6 32. A passenger airbag system for an automotive vehicle having a passenger
compartment, a windshield, and an instrument panel disposed between the passenger
8 compartment and windshield, the passenger airbag system comprising:

a single airbag housing disposed in the instrument panel, the single housing extending
10 from a top portion of the instrument panel to a mid portion of the instrument panel;

an airbag deployable from the housing through the instrument panel along a
12 predetermined path for direct contact with an occupant seated in the passenger compartment, the
predetermined path being generally radial with respect to the surface of the instrument panel.
14

33. The passenger airbag system according to claim 1, wherein the predetermined
16 path substantially lacks a downward or upward directional component relative to the occupant.

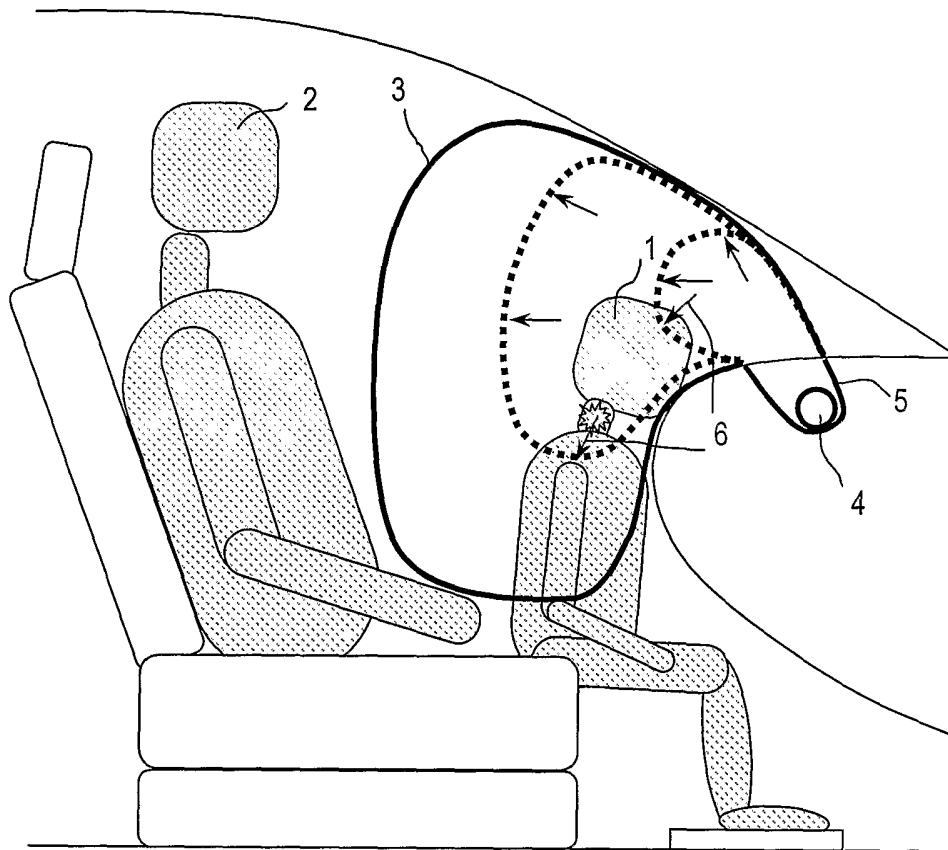


Fig. 1 (Prior Art)

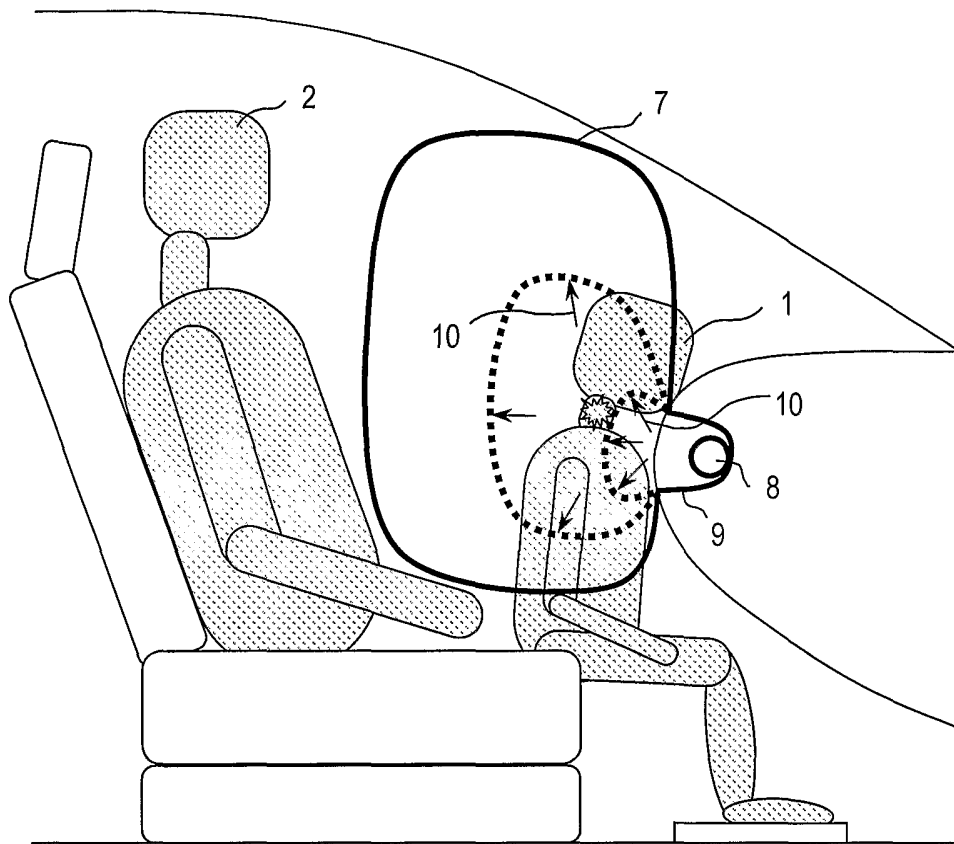


Fig. 2 (Prior Art)

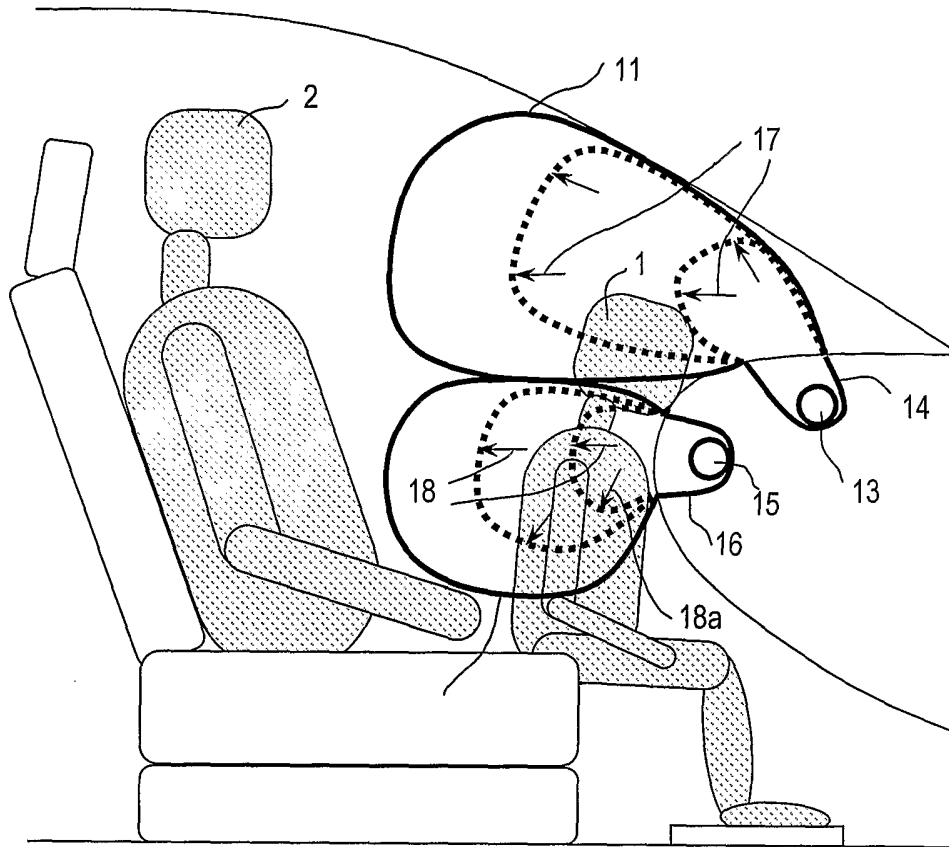


Fig. 3

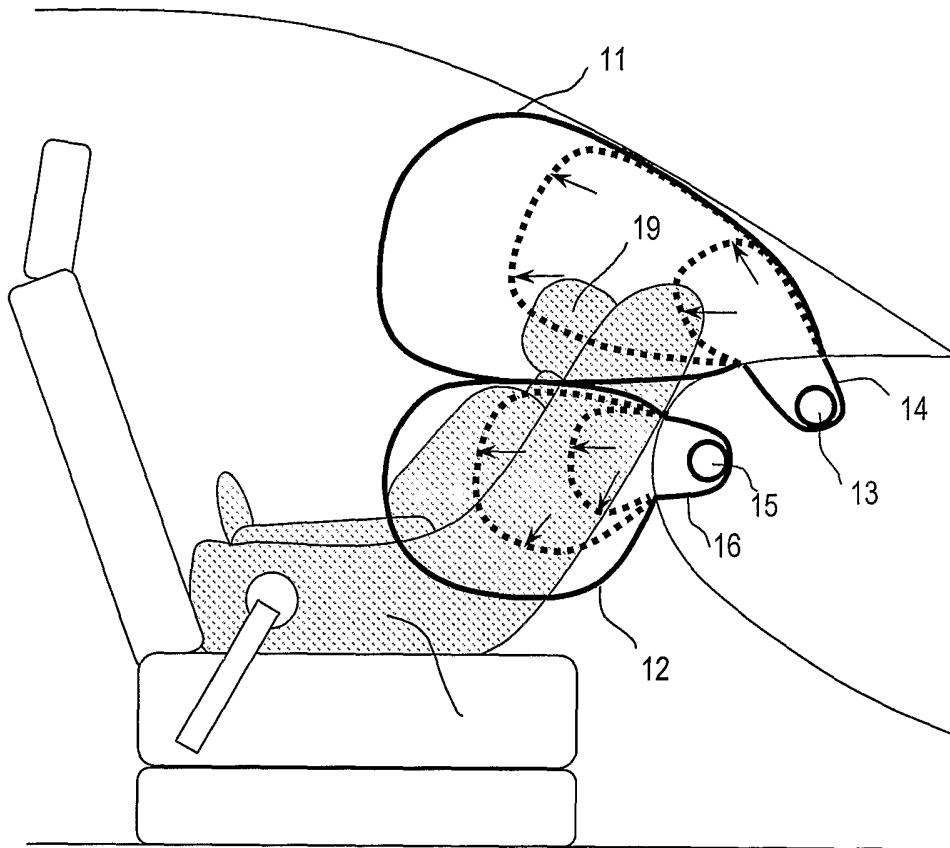


Fig. 4

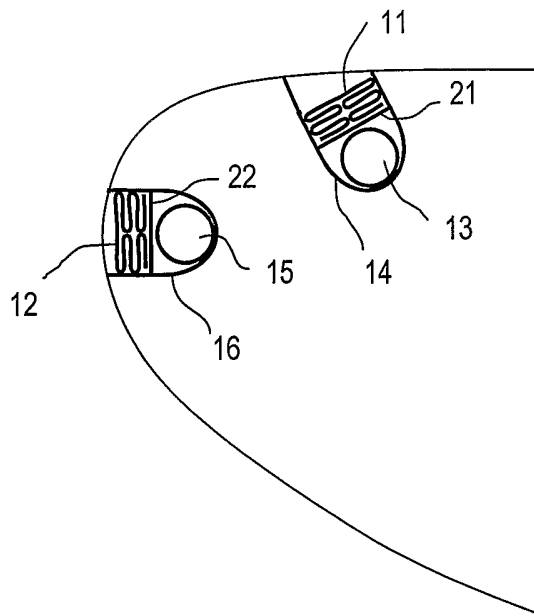


Fig. 5

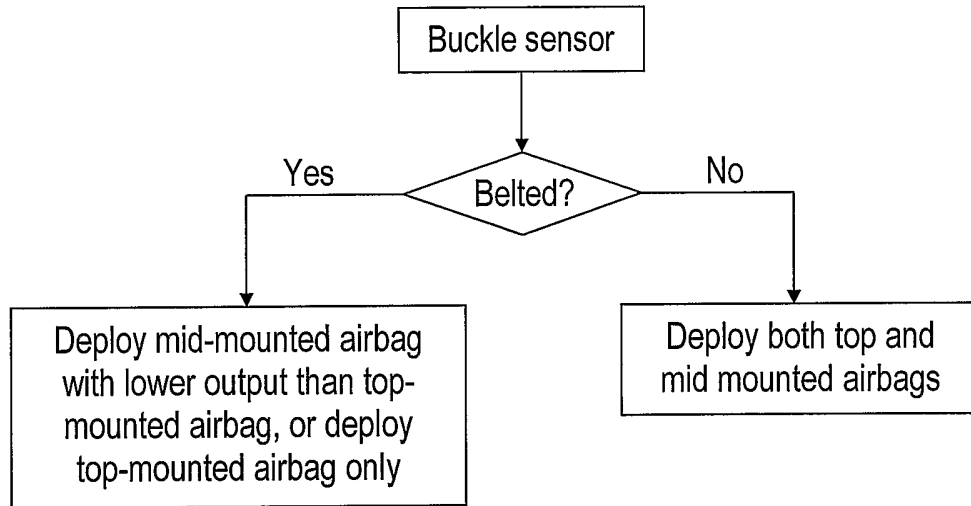


Fig. 6

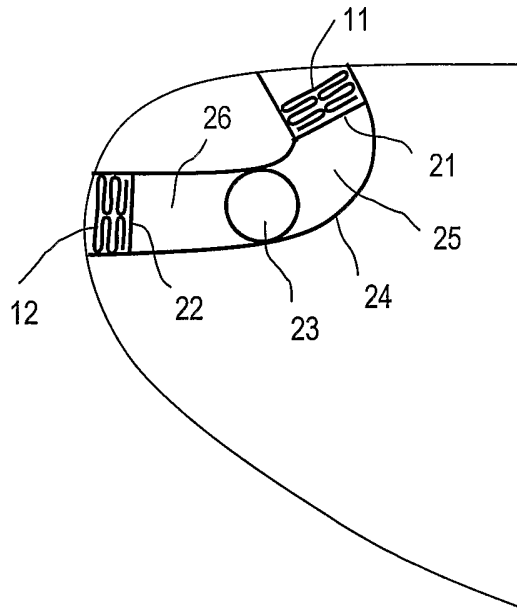


Fig. 7

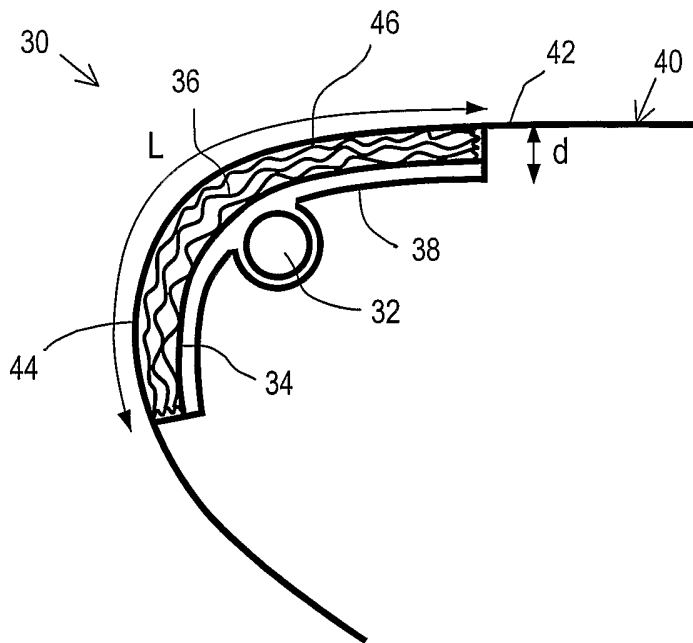


Fig. 8

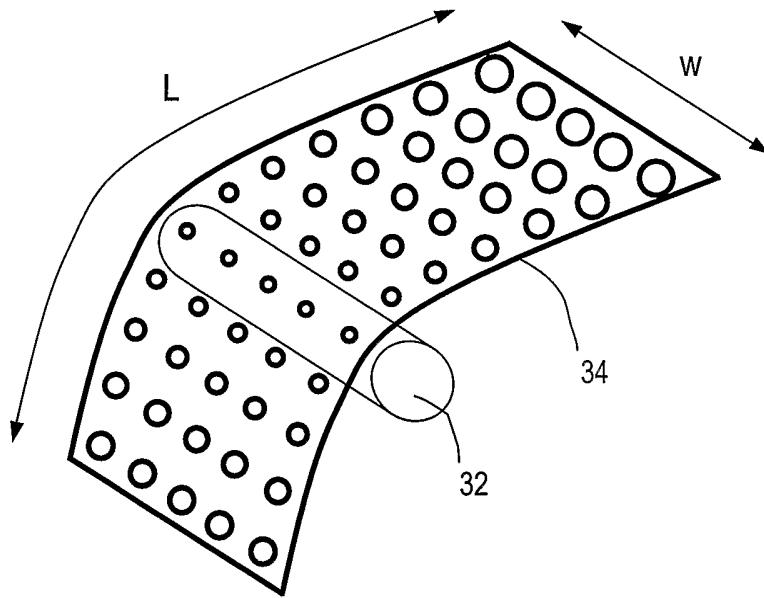


Fig. 9

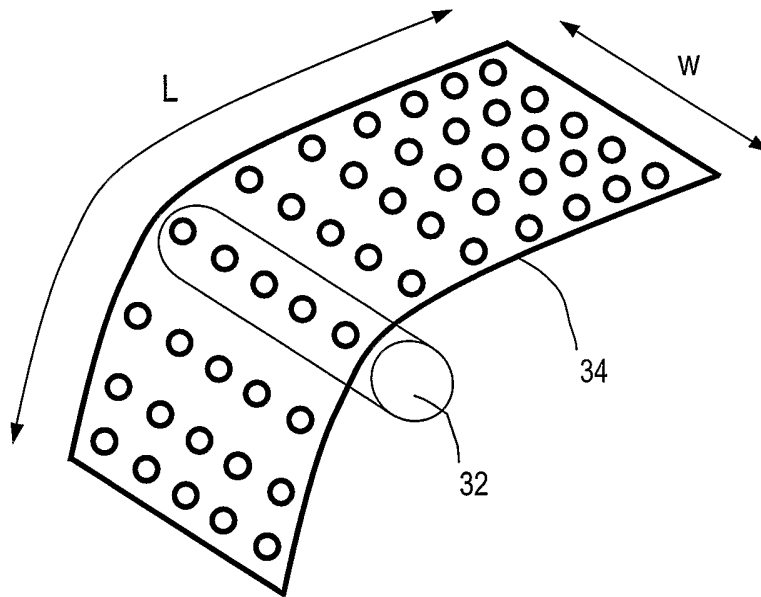


Fig. 10

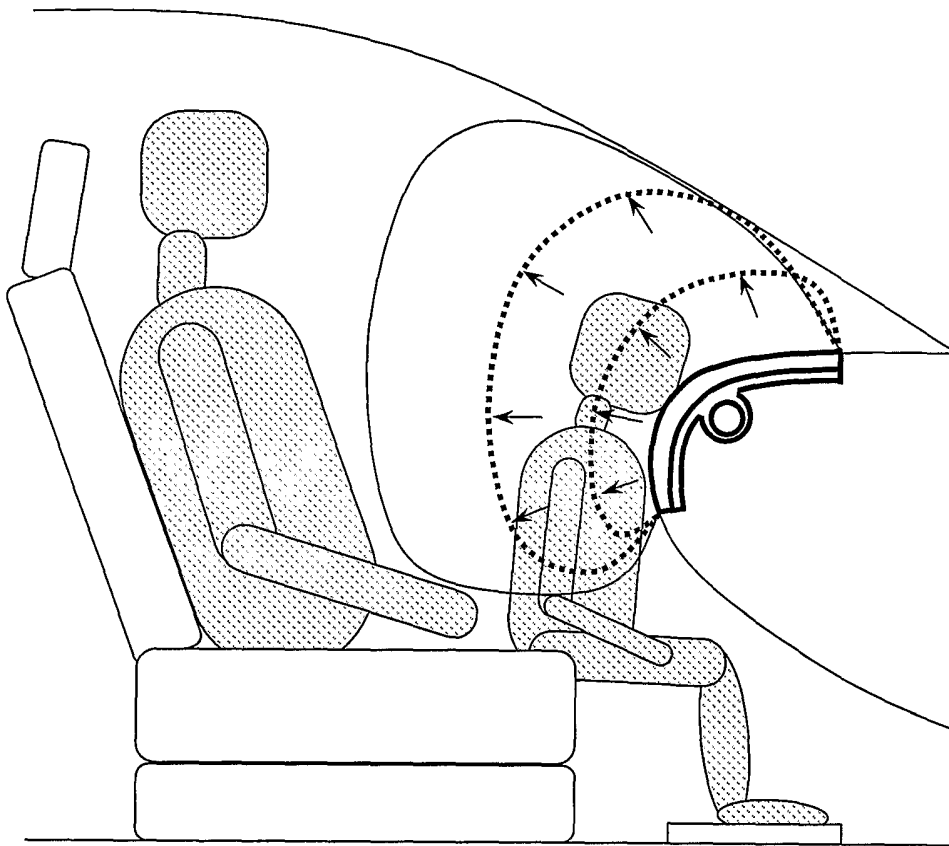


Fig. 11