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Deployable device for vehicle door

Abstract

A trim panel assembly for a vehicle door includes a trim panel having an inboard side and an outboard side. An inflatable device is supported by the trim panel. The inflatable device is inflatable from an undeployed position to a deployed position. The inflatable device includes a deployable device expandable in a direction away from the inboard side of the trim panel and in a direction away from the outboard side of the trim panel from the undeployed position to the deployed position. The deployable device is a thermoplastic elastomer. The inflatable device includes an airbag supported by the deployable device in the inflated position. The airbag is a woven fabric.

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Background/Summary

BACKGROUND

(1) Vehicles are equipped with airbag assemblies that include an airbag and an inflator. In the event of a vehicle impact, the inflator activates and provides inflation medium to the airbag. This pressurizes the airbag to control the kinematics of an occupant during the vehicle impact. The airbag assemblies may be located at various positions in passenger compartment of the vehicle.

Vehicles may include airbags supported on a dash, side air curtains mounted to roof rails, seat-mounted airbag, etc.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIG. **1** is a cut-away view of a vehicle with an inflatable assembly in an uninflated position.

(2) FIG. **2** is the cut-away view of the vehicle with the inflatable assembly in an inflated position.

(3) FIG. **3** is a front view of a portion of the vehicle with the inflatable assembly in the inflated position.

(4) FIG. **4** is a front view of a portion of the vehicle with the inflatable assembly in the inflated position.

(5) FIG. **5** is a perspective view of a door of the vehicle with one example of the inflatable assembly in the uninflated position.

(6) FIG. **6** is the perspective view of FIG. **5** with the inflatable assembly in the inflated position.

(7) FIG. **7** is a perspective view of a door of the vehicle with another example of the inflatable assembly in the uninflated position.

(8) FIG. **8** is the perspective view of FIG. **7** with the inflatable assembly in the inflated position.

DETAILED DESCRIPTION

(9) With reference to the Figures, wherein like numerals indicate like parts throughout the several views, a trim panel assembly **12** for a vehicle door **14** includes a trim panel **16** having an inboard side **18** and an outboard side **20**. An inflatable device **22** is supported by the trim panel **16**. The inflatable device **22** is inflatable from an undeployed position (FIGS. **1**, **5**, **7**) to a deployed position (FIGS. **2**-**4**, **6**, **8**). The inflatable device **22** includes a deployable device **24** expandable in a direction D**1** away from the inboard side **18** of the trim panel **16** and in a direction D**2** away from the outboard side **20** of the trim panel **16** from the undeployed position to the deployed position. The deployable device **24** is a thermoplastic elastomer. The inflatable device **22** includes an airbag **26** supported by the deployable device **24** in the inflated position. The airbag **26** is a woven fabric.

(10) The vehicle door **14** includes an outer door panel **28**, and the trim panel **16** is supported on the outer door panel **28**. The inflatable device **22** is between the outer door panel **28** and the trim panel **16**. The deployable device **24** is expandable in a direction D**2** away from the outer door panel **28** from the undeployed position to the deployed position.

(11) The vehicle **10** includes a vehicle seat **30** defining a pelvis area **32** positioned inboard of the vehicle door **14**. The deployable device **24** is expandable toward the pelvis area **32** from the uninflated position to the inflated position.

(12) When the trim panel assembly **12** is mounted on the door **14** in the vehicle **10**, the inflatable device **22** operates as both a pelvis pusher between the door **14** and the pelvis of an occupant of the seat **30** and a supplemental restraint between the torso of the occupant and the door **14**. Specifically, the deployable device **24** in the inflated position uses the outer door panel **28** as a reaction surface and expands toward the pelvis area **32** of the seat **30** to control the kinematics of the pelvis of the occupant. Since the airbag **26** is supported by the deployable device **24**, the deployable device **24** moves the airbag **26** toward the seat **30** as the deployable device **24** expand from the uninflated position to the inflated position. The deployable device **24** positions the airbag **26** for upward expansion from the uninflated position to the inflated position. In the inflated position, the airbag **26** is positioned between the torso of the occupant and the door **14** to control the kinematics of the torso of the occupant.

(13) The vehicle **10** may be any suitable type of automobile, e.g., a passenger or commercial automobile such as a sedan, a coupe, a truck, a sport utility, a crossover, a van, a minivan, a taxi, a bus, etc. With reference to FIG. **1**, the vehicle **10** defines a vehicle-longitudinal axis L extending

between a front end (not numbered) and a rear-end (not numbered) of the vehicle **10**. The vehicle **10** defines a vehicle-lateral axis A extending cross-vehicle from one side to the other side of the vehicle **10**. The vehicle **10** defines a vertical axis V extending through a floor and roof of the vehicle **10**. The vehicle-longitudinal axis L, the vehicle-lateral axis A, and the vertical axis V are perpendicular relative to each other.

(14) The vehicle **10** includes a vehicle body. The vehicle body may be of a unibody construction in which a vehicle frame and the vehicle body are unitary (including frame rails, pillars, roof rails, etc.). As another example, the vehicle body and a vehicle frame may have a body-on-frame construction (also referred to as a cab-on-frame construction) in which the vehicle body and vehicle frame are separate components, i.e., are modular, and the body is supported on and affixed to the frame. Alternatively, the vehicle body may have any suitable construction. The vehicle body may be of any suitable material, for example, steel, aluminum, and/or fiber-reinforced plastic, etc.

(15) The vehicle body includes body panels. The body panels may include structural panels, e.g., rockers, pillars, roof rails, etc. The body panels may include exterior panels. The exterior panels may present a class-A surface, e.g., a finished surface exposed to view by a customer and free of unaesthetic blemishes and defects. The body panels include, e.g., a roof panel, doors, fenders, hood, decklid, etc. The vehicle body may define an occupant cabin **34** to house occupants of the vehicle **10**.

(16) The doors **14** of the vehicle **10** are openable for occupants to enter and exit the occupant cabin **34**. The roof may contact a top edge of the doors **14** when the doors **14** are closed. The door **14** has a vehicle-forward end and a vehicle-rearward end. The door **14** may be hinged to the rest of the vehicle body at the vehicle-forward end for rotation between an open position and a closed position. In the example shown in the Figures, the front left door includes the airbag **26** and trim panel **16** described herein. Any one, more than one, or all of the doors **14** of the vehicle **10** may include the inflatable device **22** and the trim panel **16**.

(17) With reference to FIG. **3**, the door **14** includes the outer door panel **28**, and the trim panel **16** is supported on the outer door panel **28**. Specifically, the outer door panel **28** may include two panels, namely an inner panel **36** and an outer panel **38**. In such an example, the trim panel **16** and the outer panel **38** are fixed to the inner panel **36**. The trim panel **16** is positioned opposite the outer panel **38** relative to the inner panel **36**. The door **14** has a vehicle-exterior surface **40** and a vehicle-interior surface **42**, and the trim panel **16** is disposed on the vehicle-interior surface **42**. In the example shown in the Figures, outer panel **38** has the vehicle-interior surface **42** and the inner panel **36** has the vehicle-exterior surface **40**. The trim panel **16** is inboard relative to the inner panel **36**, and the outer panel **38** is outboard relative to the inner panel **36**.

(18) The door includes a window opening that may be completely closed by a window when the window is in a fully raised position. The window opening is defined by the trim panel **16** and outer panel **38** on a bottom edge and either by the inner panel **36** circumscribing the window opening or by the vehicle **10** body, e.g., the pillars and/or the roof. The outer panel **38** faces outboard relative to the vehicle **10**. The outer door panel **28**, e.g., the inner panel **36**, has a vehicle-forward end and a vehicle-rearward end. The trim panel **16** has a vehicle-forward end and a vehicle-rearward end.

(19) The outer panel **38**, e.g., the vehicle-exterior surface **40** of the outer panel **38**, may define a portion of the exterior of the vehicle **10**. For example, the vehicle-exterior surface **40** of the outer panel **38** may present a class-A surface, i.e., a surface specifically manufactured to have a high-quality, finished aesthetic appearance free of blemishes. The outer panel **38** may be metal (such as steel, aluminum, etc.) or polymeric (such as fiber reinforced plastic composite, etc.).

(20) The inner panel **36** may be metal (such as steel, aluminum, etc.) or polymeric (such as fiber reinforced plastic composite, etc.). The inner panel **36** may provide structural rigidity for the outer panel **38**. The inner panel **36** may provide a mounting location for components of the door **14**.

(21) The trim panel **16** is supported by the outer door panel **28**. In other words, the weight of the trim panel **16** is borne by the outer door panel **28**. The trim panel **16** may be, for example,

supported by the inner panel **36** of the outer door panel **28**. The trim panel **16** is fixed to the outer door panel **28**. In the example shown in the Figures, the trim panel **16** is fixed to the inner panel **36** of the door panel. The trim panel **16** may be fixed to the inner panel **36** with any suitable type of fasteners, such as Christmas-tree fasteners.

(22) The trim panel **16** may include a core and a covering. The core may be, for example, plastic, and may be rigid relative to the covering. The covering may include upholstery, padding, etc. The upholstery may be cloth, leather, faux leather, or any other suitable material. The covering is exposed to the occupant cabin **34** and may have a class-A surface, i.e., a surface specifically manufactured to have a high quality, finished aesthetic appearance free from blemishes.

(23) The trim panel **16** has an inboard side **18** and an outboard side **20**. The outboard side **20** faces the outer door panel **28** and the inboard side **18** faces the occupant cabin **34**. The outboard side **20** is vehicle-outboard of the inboard side **18**, i.e., the inboard side **18** is vehicle-inboard of the outboard side **20**. The inboard side **18** faces the occupant cabin **34** and is exposed to the occupant cabin **34**. The inboard side **18** may include the class-A surface. For example, the covering having the class-A surface may be on the inboard side **18**.

(24) The vehicle **10** includes one or more seats **30** in the occupant cabin **34**. The vehicle **10** may include any suitable number of seats **30**. The seats **30** may be arranged in the occupant cabin **34** in any suitable position, i.e., as front seats, rear seats, third-row seats, etc. The seat **30** may be movable relative to the floor to various positions, e.g., movable fore-and-aft and/or cross-vehicle. The seats **30** may be of any suitable type, e.g., a bucket seat. The vehicle **10** may include any suitable number of seats **30**, and any one or more of the seats **30**. The vehicle **10** may include one or more trim panels **16** and inflatable device **22***s* with each trim panel **16**/inflatable device **22** being adjacent a respective one of the seats **30**.

(25) Each seat **30** includes a seat bottom **44** and a seatback **46**. The seat bottom **44** extends from the seatback **46** in a seat-forward direction SF. The seatback **46** may be supported by the seat bottom **44** and may be stationary or movable relative to the seat bottom **44**. The seatback **46** and the seat bottom **44** may be adjustable in multiple degrees of freedom to vary recline angle of the seatback **46**. Specifically, the seatback **46** and the seat bottom **44** may themselves be adjustable, in other words, adjustable components within the seatback **46** and/or the seat bottom **44**, and/or may be adjustable relative to each other.

(26) The seat bottom **44** and the seatback **46** each include a frame (not numbered) and a covering (not numbered) supported on the frame. The frame of the seat bottom **44** and seatback **46** may include tubes, beams, etc., and may be of any suitable material such as plastic (e.g., carbon fiber reinforced plastic (CFRP), glass fiber-reinforced semi-finished thermoplastic composite (organosheet), etc.) and/or metal (e.g., steel, aluminum, etc.).

(27) The covering of the seat **30** may include upholstery and padding. The upholstery may be cloth, leather, faux leather, or any other suitable material. The upholstery may be stitched in panels around the frame of the seat bottom **44** and/or seatback **46**. The padding may be between the covering and the frame and may be foam or any other suitable material.

(28) The seat **30**, specifically the seatback **46** and the seat bottom **44**, define an occupant-seating area **48**. The occupant-seating area **48** is the space occupied by an occupant properly seated on the seat **30**. The occupant-seating area **48** is seat-forward of the seatback **46** and above the seat bottom **44**. The occupant-seating area **48** is on a front side of the seatback **46**.

(29) The occupant-seating area **48** includes the pelvis area **32** seat forward of the seatback **46**. The pelvis area **32** is configured to receive the pelvis of an occupant of the seat **30** when the occupant is properly seated in the seat **30**. The pelvis area **32** is positioned inboard of the vehicle door **14**. The pelvis area **32** is adjacent the trim panel **16** of the vehicle door **14**.

(30) The seatback **46** may have bolsters on opposite sides of the occupant-seating area **48**. One bolster is on an inboard side of the seat **30** and one bolster is on an outboard side of the seat **30**, and specifically, one bolster may be on the inboard side of the frame of the seatback **46** and the other

bolster may be on the outboard side of the frame of the seatback **46**. The bolsters are elongated, and specifically, are elongated in a generally upright direction when the seatback **46** is in a generally upright position. The bolsters define cross-seat boundaries of the seatback **46**, i.e., the seatback **46** terminates at the bolsters. The bolsters may extend in a seat-forward direction SF relative to the occupant-seating area **48**, i.e., on opposite sides of the torso and shoulders of an occupant seated on the seat **30**.

(31) The seat **30** defines the seat-forward direction SF. The seat-forward direction SF extends forward relative to the seat **30**. For example, the seat-forward direction SF may extend from a rear of the seat **30** to a front of the seat **30** relative to an occupant of the seat **30**, i.e., the occupant of the seat **30** faces in the seat-forward direction SF when properly seated in the seat **30**. The seat bottom **44** extends from the seatback **46** in the seat-forward direction SF. The seat **30** defines a cross-seat axis CS and a seat-upright axis SU. A cross-seat direction CD extends in parallel with the cross-seat axis CS. The seat **30** includes a seat-forward axis FA, and the seat-forward direction SF is parallel to the seat-forward axis FA. The seat-forward axis FA, the cross-seat axis CS, and the seat-upright axis SU are perpendicular to each other. The seat-forward axis FA is parallel with the vehicle-longitudinal axis L when the seat **30** is forward facing and when the seat **30** is rearward facing, the cross-seat axis CS is parallel with the cross-vehicle axis A when the seat **30** is forward facing and when the seat **30** is rearward facing, and the seat-upright axis SU extends through the vehicle **10** floor and the vehicle **10** roof when the seatback **46** is in an upright position.

(32) The seat **30** includes a first side **50** and a second side **52**. The first side **50** is spaced from the second side **52** along the cross-seat axis CS. The numerical adjectives “first” and “second” are used herein as identifiers and do not indicate order or importance. In the example shown in the Figures, when the seat **30** is in a forward-facing position, the second side **52** of the seat **30** is vehicle-inboard of the first side **50** of the seat **30**, and the first side **50** of the seat **30** is vehicle-outboard of the second side **52** of the seat **30**.

(33) The vehicle **10** includes a seatbelt assembly for each seat **30**. The seatbelt assembly may be a three-point harness, meaning that the webbing is attached at three points around the occupant when fastened: the anchor, the seatbelt retractor, and the buckle. The seatbelt assembly may, in other examples, include another arrangement of attachment points.

(34) The inflatable device **22** includes the deployable device **24**, the airbag **26**, and an inflator **54**. The inflator **54** supplies inflation medium to the deployable device **24** and the airbag **26** to deploy the deployable device **24** and the airbag **26** to the inflated position. In the inflated position, the deployable device **24** controls the kinematics of the pelvis of the occupant of the seat **30** and the airbag **26** controls the kinematics of the torso of the occupant of the seat **30**, as described above. The deployable device **24** has an inflation chamber in fluid communication with the inflator **54** and the airbag **26** has an inflation chamber in fluid communication with the inflator **54**, as described further below. The inflation chamber of the deployable device **24** may be in fluid communication with the inflation chamber of the airbag **26**, as shown in the example in the Figures.

(35) The deployable device **24** is a thermoplastic elastomer (TPE). The TPE has both thermoplastic and elastomeric properties. Example thermoplastic elastomers include styrenic block copolymers, thermoplastic olefins, elastomeric alloys, thermoplastic polyurethanes, thermoplastic copolyesters, and thermoplastic polyamides. Walls **56** of the deployable device **24** may each have a wall **56** thickness of 1-3 mm. The walls **56** of the deployable device **24***s* are solid, i.e., not woven, fabric, sewn, etc. One or more walls **56** of the deployable device **24** may include folds, e.g., in an accordion shape, to allow the deployable device **24** to expand, as described below, from the uninflated position to the inflated position. The walls **56** of the deployable device **24** may maintain thickness, i.e., do not appreciably stretch and thin, as the deployable device **24** expands from the uninflated position to the inflated position.

(36) The deployable device **24** may be formed using any suitable manufacturing process, e.g., injection molding, blow molding, etc. The walls **56** of the deployable device **24** may be unitary.

Unitary means a single, uniform piece of material with no seams, joint **58***s*, fasteners, or adhesives holding the walls **56** together, i.e., the walls **56** are formed together simultaneously as a single continuous unit. Non-unitary components, in contrast, are formed separately and subsequently assembled, e.g., by welding, bonding, adhesive, etc.

(37) The airbag **26** is inflatable from the deployable device **24** from the uninflated position to the inflated position. The airbag **26** may be woven fabric, e.g., a woven polymer. As an example, the airbag **26** may be woven nylon yarn, for example, nylon 6, 6. Other examples of woven polymers include polyether ether ketone PEEK, polyetherketoneketone PEKK, polyester, etc. The woven polymer may include a coating, such as silicone, neoprene, urethane, etc. For example, the coating may be polyorgano siloxane. One or more woven fabric panels of the airbag **26** may enclose the inflation chamber of the airbag **26**.

(38) The airbag **26** is directly connected to the deployable device **24**. As an example, the airbag **26** is directly connected to the wall **56** of the deployable device **24** with the inflation chamber of the airbag **26** open to the inflation chamber of the deployable device **24** (as shown with arrows in **6** and **8**). As one example, the deployable device **24** may be over-molded on the airbag **26** at a joint **58** between the deployable device **24** and the airbag **26**. "Over-molded" is used herein as a structural description of the joint **58**, not the process by which the joint **58** is made. In other words, the over-molded joint **58** has the structure of an over-molded component unitarily connecting the airbag **26** to the deployable device **24**. When over-molded, the joint **58** joins the airbag **26** to the deployable device **24** without fasteners or adhesives holding the airbag **26** and the deployable device **24** together. In such an example, the joint **58** has a shape that conforms to a mold, e.g., an injection mold, used to form the deployable device **24** to form the joint **58** as an over-molded component to airbag **26**. In such an example, the joint **58** is unitary with the deployable device **24**. In other examples, the airbag **26** may be connected to the deployable device **24** by adhesive, bonding, welding, etc.

(39) In some examples, the inflatable device **22** may be supported directly by the outer door panel **28** of the door **14**, e.g., the outer panel **38** of the outer door panel **28**. In such an example, the deployable device **24** may be directly connected to the outer door panel **28** and supported by the outer door panel **28**. In such an example, the deployable device **24** may be fastened to the outer panel **38**. As an example, the deployable device **24** may include fastening features **60** unitary with the walls **56** of the deployable device **24**. As an example, the fastening features **60** may be fasteners, e.g., Christmas-tree fasteners, clips, etc., that are unitary with the walls **56** and/or that receive fasteners, such as holes (as shown in FIGS. **3**-**4**), clips, etc., that receive a fastener such as a threaded fastener, Christmas tree fastener, clip, etc. In examples in which the deployable device **24** is directly connected to the outer panel **38** of the door, the deployable device **24** may abut the outer panel **38** of the door in the inflated position and in the uninflated position. In such examples, the inflatable device **22** uses the outer panel **38** of the door as a reaction surface and expands away from the outer panel **38** into the occupant cabin **34** from the uninflated position to the inflated position.

(40) In some examples, the inflatable device **22** may be supported by the trim panel **16**, i.e., the weight of the inflatable device **22** may be borne by the trim panel **16**, in the uninflated position and in the inflated position, as shown in the example in FIGS. **7**-**8**. As one example, the deployable device **24** may be directly connected to the trim panel **16** and supported by the trim panel **16**. In such an example, the deployable device **24** may be fastened to the trim panel **16**, as shown in the example in FIGS. **7**-**8**. As an example, the deployable device **24** may include fastening features **60** unitary with the walls **56** of the deployable device **24**. As an example, the fastening features **60** may be fasteners, e.g., Christmas-tree fasteners, clips, etc., that are unitary with the walls **56** and/or may include features that receive fasteners, such as holes (as shown in FIGS. **7**-**8**), clips, etc., that receive a fastener such as a threaded fastener, Christmas tree fastener, clip, etc.

(41) In examples in which the inflatable device **22** is supported by the trim panel **16**, the deployable

device **24** may be spaced from the outer panel **38** of the door in the uninflated position and may abut the outer panel **38** of the door in the inflated position. In such examples, the deployable device **24** expands to the outer panel **38** of the door and expands away from the outer panel **38** into the occupant cabin **34**, as shown in FIGS. **7**-**8**. In other words, the deployable device **24** is expandable in a direction D**1** away from the inboard side **18** of the trim panel **16** and in a direction D**2** away from the outboard side **20** of the trim panel **16** from the undeployed position to the deployed position. In such examples, the deployable device **24** uses the outer panel **38** as a reaction surface. In other examples in which the inflatable device **22** is supported by the trim panel **16**, the deployable device **24** may abut the outer panel **38** of the door **14** in both the uninflated position and the inflated position, and in such examples, the inflatable device **22** expands into the occupant cabin **34** from the uninflated position to the inflated position.

(42) The deployable device **24** may include an exposed surface **62** exposed to the occupant cabin **34**. In such an example, the exposed surface **62** may be flush with the inboard side **18** of the trim panel **16**. In other words, the exposed surface **62** is immediately adjacent to the inboard side **18** of the trim panel **16** and follows the contours of the inboard side **18** of the trim panel **16** around the entire circumference of the exposed surface **62** of the deployable device **24**. In examples in which the deployable device **24** includes the exposed surface **62** exposed to the occupant cabin **34**, the exposed surface **62** may be a class-A surface, i.e., a surface specifically manufactured to have a high-quality, finished aesthetic appearance free of blemishes. The TPE of the deployable device **24** may be manufactured with the exposed surface **62** being a class-A surface, e.g., the TPE may be textured in the molding process to match the contours and texture of the adjacent inboard surface of the trim panel **16**. In such examples, the deployable device **24** may be integrated with the trim panel **16**, either by unitary formation or subsequent assembly, without an additional covering over the deployable device **24**.

(43) The inflatable device **22**, including the deployable device **24**, the airbag **26**, and the inflator **54**, may be assembled to the vehicle door **14** (e.g., the trim panel **16** or the door panel) as a unit. As one example, the trim panel **16** may have a hole **64** and the deployable device **24** may be mounted to the trim panel **16** with the exposed surface **62** filling the hole **64**. As another example, the trim panel **16**, or a portion of the trim panel **16**, may be over-molded to the deployable device **24**. When the inflatable device **22** is assembled to the trim panel **16** and the trim panel **16** is assembled to the outer panel **38** of the door, the inflatable device **22** is between the trim panel **16** and the outer panel **38**. In other words, at least a portion of the inflatable device **22** is in a space between the trim panel **16** and the outer panel **38** in the uninflated position.

(44) The airbag **26** is supported by the deployable device **24** in the uninflated position and in the inflated position. In the uninflated position, the airbag **26** may be rolled or folded on deployable device **24** in the uninflated position. The airbag **26** moves with the deployable device **24** as the deployable device **24** expands away from the outer panel **38** of the door into the occupant cabin **34**. Specifically, the joint **58** between the airbag **26** and the deployable device **24** moves vehicle-inboard away from the outer panel **38** of the door **14** into the occupant cabin **34** as the deployable device **24** expands. The airbag **26** expands upwardly from the deployable device **24** into the occupant cabin **34**, specifically, between the door **14** and the occupant to control the kinematics of the occupant. In some examples, the airbag **26** is elongated in an upward direction U from the deployable device **24** in the inflated position. In other words, the longest dimension of the airbag **26** is in the upward direction U from the deployable device **24**. The upward direction U may be vertical. The properties of the TPE that aid in expansion characteristics and the shape, size, and dimensions of the inflatable device **22***s* in the inflated position allow for specific deployment of the deployable device **24** into the occupant cabin **34** to position the airbag **26** for upward inflation.

(45) In some examples, the deployable device **24** may include more than one chamber. In the example shown in FIGS. **7**-**8**, the deployable device **24** includes a first chamber **66** a second chamber **68**, and an interior panel **70** between the first chamber **66** and the second chamber **68**. The

first chamber **66** and the second chamber **68** are components of the inflation chamber of the deployable device **24**, and the interior panel **70** divides the inflation chamber of the deployable device **24** into the first chamber **66** and the second chamber **68**. In such examples, the first chamber **66** that expands away from the outer door panel **28** into the occupant cabin **34** from the undeployed position to the deployed position. In such an example, the first chamber **66** expands in a direction D**1** away from the inboard side **18** of the trim panel **16**. The second chamber **68** expands to the outer door panel **28** from the undeployed position to the deployed position, i.e., at least one wall **56** defining the second chamber **68** abuts the outer panel **38** in the deployed position. In such an example, the second chamber **68** expands in a direction D**2** away from the outboard side **20** of the trim panel **16**. In such examples, the airbag **26** is supported by the first chamber **66** and moves with the first chamber **66** into the occupant cabin **34** as the inflatable device **22** expands from the uninflated position to the inflated position.

(46) In some examples, the interior panel **70** may fluidly separate the first chamber **66** from the second chamber **68**. In such examples, the inflator **54** may be directly connected to both the first chamber **66** and the second chamber **68**, e.g., through fill tubes, diffuser tubes, etc. In some examples, the interior panel **70** may include vents, baffles, diffusers, etc., that allow selective or diffused flow of inflation medium between the first chamber **66** and the second chamber **68**.

(47) The inflator **54** is in fluid communication with the deployable device **24** and the airbag **26**. In other words, inflation medium from the inflator **54** flows into the inflation chambers of the deployable device **24** and the airbag **26** to expand the inflatable device **22** to the inflated position. The inflator **54** expands the deployable device **24** and the airbag **26** with inflation medium, such as a gas, to move the inflatable device **22** from the uninflated position to the inflated position. The inflator **54** may be, for example, a pyrotechnic inflator that ignites a chemical reaction to generate the inflation medium, a stored gas inflator **54** that releases (e.g., by a pyrotechnic valve) stored gas as the inflation medium, or a hybrid. The inflator **54** may be, for example, at least partially in the inflation chamber of the deployable device **24** to deliver inflation medium directly to the inflation chamber of the deployable device **24** or may be connected to the inflation chamber of the deployable device **24** through fill tubes, diffusers, etc.

(48) The inflator **54** may be supported by any suitable component of the door **14**. As one example, the inflator **54** may be connected with and moveable as a unit with the deployable device **24**. As an example, the inflator **54** may be in the inflation chamber of the deployable device **24**. In such examples, the deployable device **24** may have mounting components, e.g., clips, fasteners, etc., that attach the inflator **54** to the deployable device **24**. In such examples, the mounting components may be unitary with a wall **56** of the deployable device **24**. In examples in which the inflator **54** is in the inflation chamber of the inflatable device **22**, the deployable device **24**, airbag **26**, and inflator **54** are assembled to the outer panel **38** of the door or the trim panel **16** as a unit. In other example, the inflator **54** may be mounted to the outer panel **38** of the door or to the trim panel **16**, and in such examples, the inflator **54** is in fluid communication with the deployable device **24** through a fill tube.

(49) In the example shown in the Figures, the inflatable device **22** defines a fluid path through the deployable device **24** from the inflator **54** to the airbag **26**. In other words, the inflator **54** supplies inflation medium directly to the inflation chamber of the deployable device **24** and the inflation medium flows through the inflation chamber of the deployable device **24** into the airbag **26**. As set forth above, in some examples, including the example in FIGS. **7**-**8**, the deployable device **24** includes the first chamber **66** and the second chamber **68**. In such an example, the deployable device **24** defines a fluid path through the first chamber **66** from the inflator **54** to the airbag **26**. In other words, inflation medium flows from the inflator **54** into the first chamber **66** and from the first chamber **66** into the airbag **26**. As set forth above, in some examples, the inflator **54** may provide inflation medium directly the first chamber **66** or may provide inflation medium to the first chamber **66** through the second chamber **68**.

(50) The vehicle **10** includes a computer that controls the activation of the inflator **54**. The computer may be, for example, a restraints control module. The computer includes a processor and a memory. The memory includes one or more forms of computer readable media, and stores instructions executable by the processor for performing various operations, including as disclosed herein. For example, the computer can be a generic computer with a processor and memory as described above and/or may include an electronic control unit ECU or controller for a specific function or set of functions, and/or a dedicated electronic circuit including an ASIC that is manufactured for a particular operation, e.g., an ASIC for processing sensor data and/or communicating the sensor data. In another example, the computer may include an FPGA (Field-Programmable Gate Array) which is an integrated circuit manufactured to be configurable by a user. Typically, a hardware description language such as VHDL (Very High Speed Integrated Circuit Hardware Description Language) is used in electronic design automation to describe digital and mixed-signal systems such as FPGA and ASIC. For example, an ASIC is manufactured based on VHDL programming provided pre-manufacturing, whereas logical components inside an FPGA may be configured based on VHDL programming, e.g. stored in a memory electrically connected to the FPGA circuit. In some examples, a combination of processor(s), ASIC(s), and/or FPGA circuits may be included in a computer. The memory can be of any type, e.g., hard disk drives, solid state drives, servers, or any volatile or non-volatile media. The memory can store the collected data sent from the sensors. The memory can be a separate device from the rest of the computer, and the computer can retrieve information stored by the memory via a network in the vehicle **10**, e.g., over a CAN bus, a wireless network, etc.

(51) The vehicle **10** may include at least one impact sensor for sensing certain vehicle **10** impacts (e.g., impacts of a certain magnitude, direction, etc.), and the computer is in communication with the impact sensor and the inflator **54**. The computer may activate the inflator **54**, e.g., provide an impulse to a pyrotechnic charge of the inflator **54** when the impact sensor senses certain vehicle **10** impacts. The impact sensor may be configured to sense certain vehicle **10** impacts prior to impact, i.e., pre-impact sensing. The impact sensor may be in communication with the computer. The impact sensor is configured to detect certain vehicle **10** impacts. In other words, a “certain vehicle **10** impact” is an impact of the type and/or magnitude for which inflation of the airbag **26** is designed i.e., “certain” indicates the type and/or magnitude of the impact. The type and/or magnitude of such “certain vehicle **10** impacts” may be pre-stored in the computer, e.g., a restraints control module. The impact sensor may be of any suitable type, for example, post contact sensors such as accelerometers, pressure sensors, and contact switches; and pre-impact sensors such as radar, LIDAR, and vision sensing systems. The vision sensing systems may include one or more cameras, CCD image sensors, CMOS image sensors, etc.

(52) The disclosure has been described in an illustrative manner, and it is to be understood that the terminology which has been used is intended to be in the nature of words of description rather than of limitation. Many modifications and variations of the present disclosure are possible in light of the above teachings, and the disclosure may be practiced otherwise than as specifically described.

Claims

1. A vehicle door comprising: an outer door panel; a trim panel supported on the outer door panel; and an inflatable device between the outer door panel and the trim panel, the inflatable device being inflatable from an undeployed position to a deployed position; the inflatable device including a deployable device expandable in a direction away from the outer door panel from the undeployed position to the deployed position, the deployable device being a thermoplastic elastomer; and the inflatable device including an airbag supported by the deployable device in an inflated position, the airbag being a woven fabric.

2. The vehicle door as set forth in claim 1, wherein the deployable device expands to the outer door

panel from the undeployed position to the deployed position.
3. The vehicle door as set forth in claim 1, wherein the airbag is elongated in an upward direction from the deployable device in the inflated position.
4. The vehicle door as set forth in claim 1, wherein: the deployable device includes a first chamber that expands away from the outer door panel from the undeployed position to the deployed position; and the deployable device includes a second chamber that expands to the outer door panel from the undeployed position to the deployed position.
5. The vehicle door as set forth in claim 4, wherein the airbag is supported by the second chamber.
6. The vehicle door as set forth in claim 5, further comprising an inflator, the inflatable device defining a fluid path through the first chamber from the inflator to the airbag.
7. The vehicle door as set forth in claim 1, further comprising an inflator, the inflatable device defining a fluid path through the deployable device from the inflator to the airbag.
8. The vehicle door as set forth in claim 1, wherein the deployable device is supported by the trim panel in an uninflated position and in the inflated position.
9. A vehicle comprising: a vehicle door; a vehicle seat defining a pelvis area positioned inboard of the vehicle door; the vehicle door including an outer door panel and a trim panel supported on the outer door panel; and an inflatable device between the outer door panel and the trim panel, the inflatable device being inflatable from an undeployed position to a deployed position; the inflatable device including a deployable device supported by the trim panel in an uninflated position and an inflated position, the deployable device being expandable toward the pelvis area from the uninflated position to the inflated position, the deployable device being a thermoplastic elastomer; and the inflatable device including an airbag supported by the deployable device in the inflated position, the airbag being a woven fabric.
10. The vehicle as set forth in claim 9, wherein the deployable device expands to the pelvic area of the seat from the undeployed position to the deployed position.
11. The vehicle door as set forth in claim 9, wherein the deployable device is spaced from the outer door panel in the uninflated position and expands to the outer door panel from the undeployed position to the deployed position.
12. The vehicle door as set forth in claim 9, wherein the airbag is elongated in an upward direction from the deployable device in the inflated position.
13. The vehicle door as set forth in claim 9, further comprising an inflator, the inflatable device defining a fluid path through the deployable device from the inflator to the airbag.
14. The vehicle door as set forth in claim 9, wherein the deployable device is supported by the trim panel in the uninflated position and the inflated position.
15. A vehicle door trim panel assembly comprising: a trim panel having an inboard side and an outboard side; and an inflatable device supported by the trim panel, the inflatable device being inflatable from an undeployed position to a deployed position; the inflatable device including a deployable device expandable in a direction away from the inboard side of the trim panel and in a direction away from the outboard side of the trim panel from the undeployed position to the deployed position, the deployable device being a thermoplastic elastomer; and the inflatable device including an airbag supported by the deployable device in an inflated position, the airbag being a woven fabric.
16. The vehicle door trim panel assembly as set forth in claim 15, wherein the inboard side includes a class-A surface.
17. The vehicle door trim panel assembly as set forth in claim 16, wherein the deployable device includes a class-A surface flush with the class-A surface of the inboard side of the trim panel.
18. The vehicle door as set forth in claim 15, wherein: the deployable device includes a first chamber expandable in the direction away from the inboard side of the trim panel from the undeployed position to the deployed position; and the deployable device includes a second chamber expandable in the direction away from the outboard side of the trim panel from the

undeployed position to the deployed position.
19. The vehicle door as set forth in claim 18, wherein the airbag is supported by the second chamber.
20. The vehicle door as set forth in claim 15, further comprising an inflator, the inflatable device defining a fluid path through the deployable device from the inflator to the airbag.