US 20140062129A1

(19) **United States**

(12) **Patent Application Publication**

Syed et al.

(10) **Pub. No.: US 2014/0062129 A1**

(43) **Pub. Date: Mar. 6, 2014**

(54) **IMPACT DEFLECTION AND ABSORPTION STRUCTURE**

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(21) Appl. No.: **13/602,418**

(22) Filed: **Sep. 4, 2012**

Publication Classification

(51) **Int. Cl.**

B60R 19/26 (2006.01)

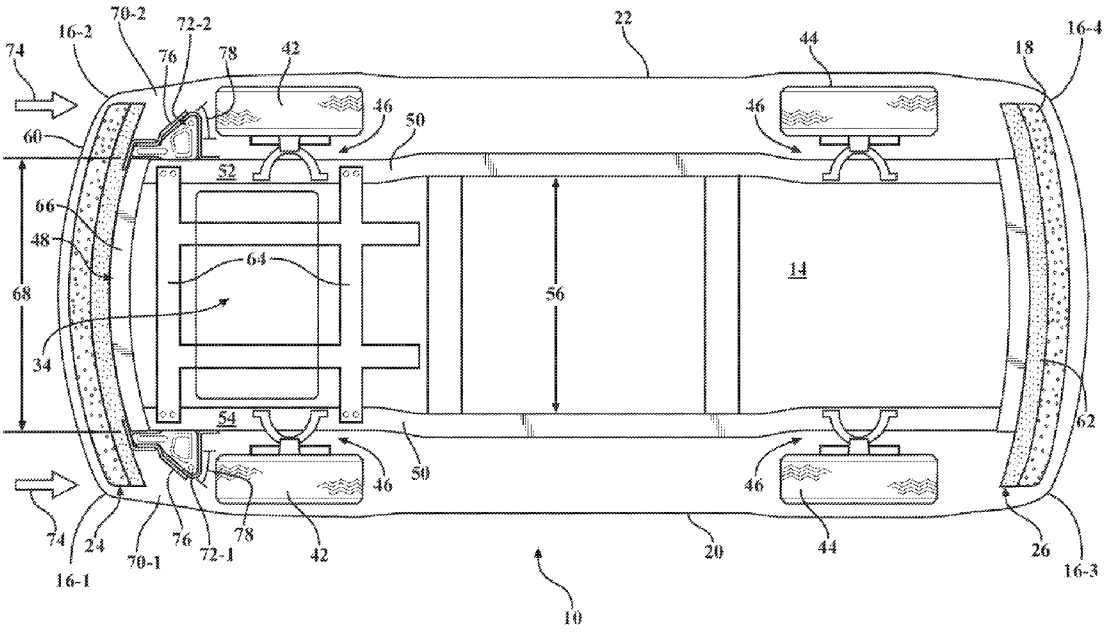
B60R 19/24 (2006.01)

(52) **U.S. Cl.**

USPC **296/187.1**; 293/132

(57) **ABSTRACT**

An impact deflection and absorption structure for a vehicle having a vehicle body that includes a passenger compartment and an under-hood compartment. The impact deflection and absorption structure includes a frame having a frame rail configured to support the vehicle body. The impact deflection and absorption structure also includes a bumper assembly secured to the frame rail. The bumper assembly includes an impact beam arranged substantially transverse to the frame rail and a lateral member secured to the impact beam. The lateral member projects away from the impact beam and is configured to counteract impact energy that is directed substantially parallel to the frame rail into the frame rail and away from the under-hood compartment and the passenger compartment. A vehicle employing the impact deflection and absorption structure is also disclosed.



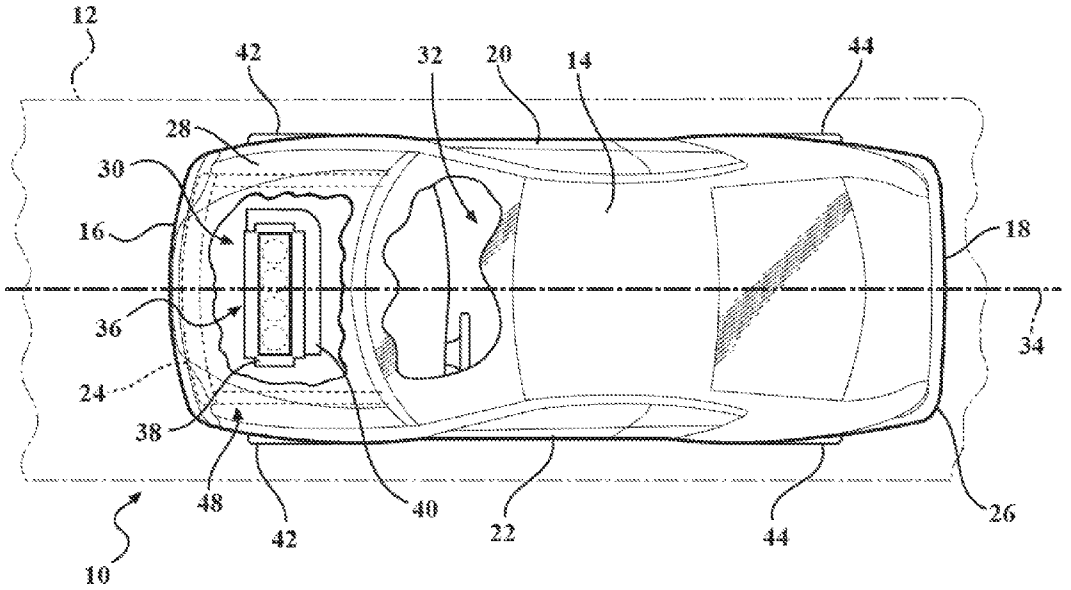

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FIG. 1

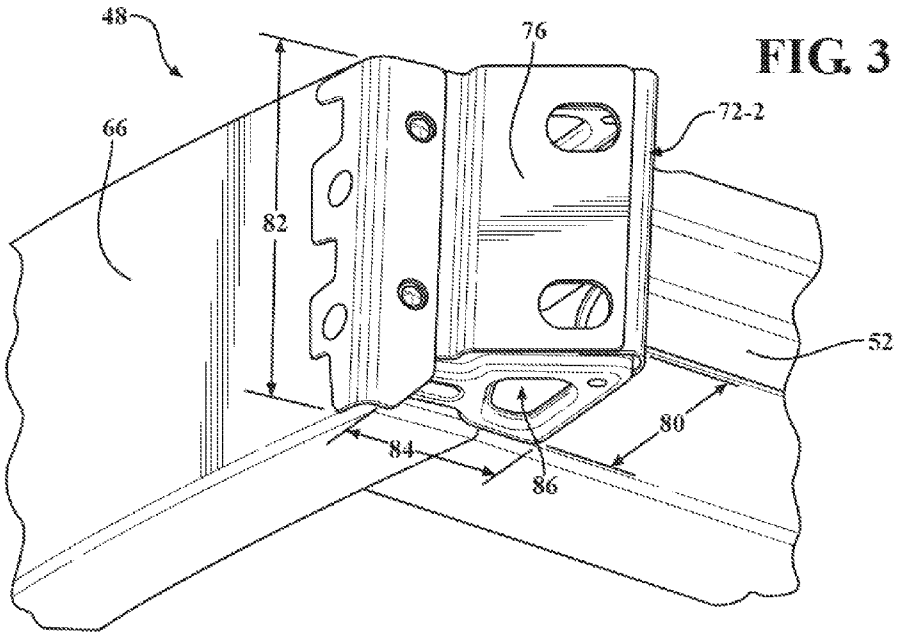
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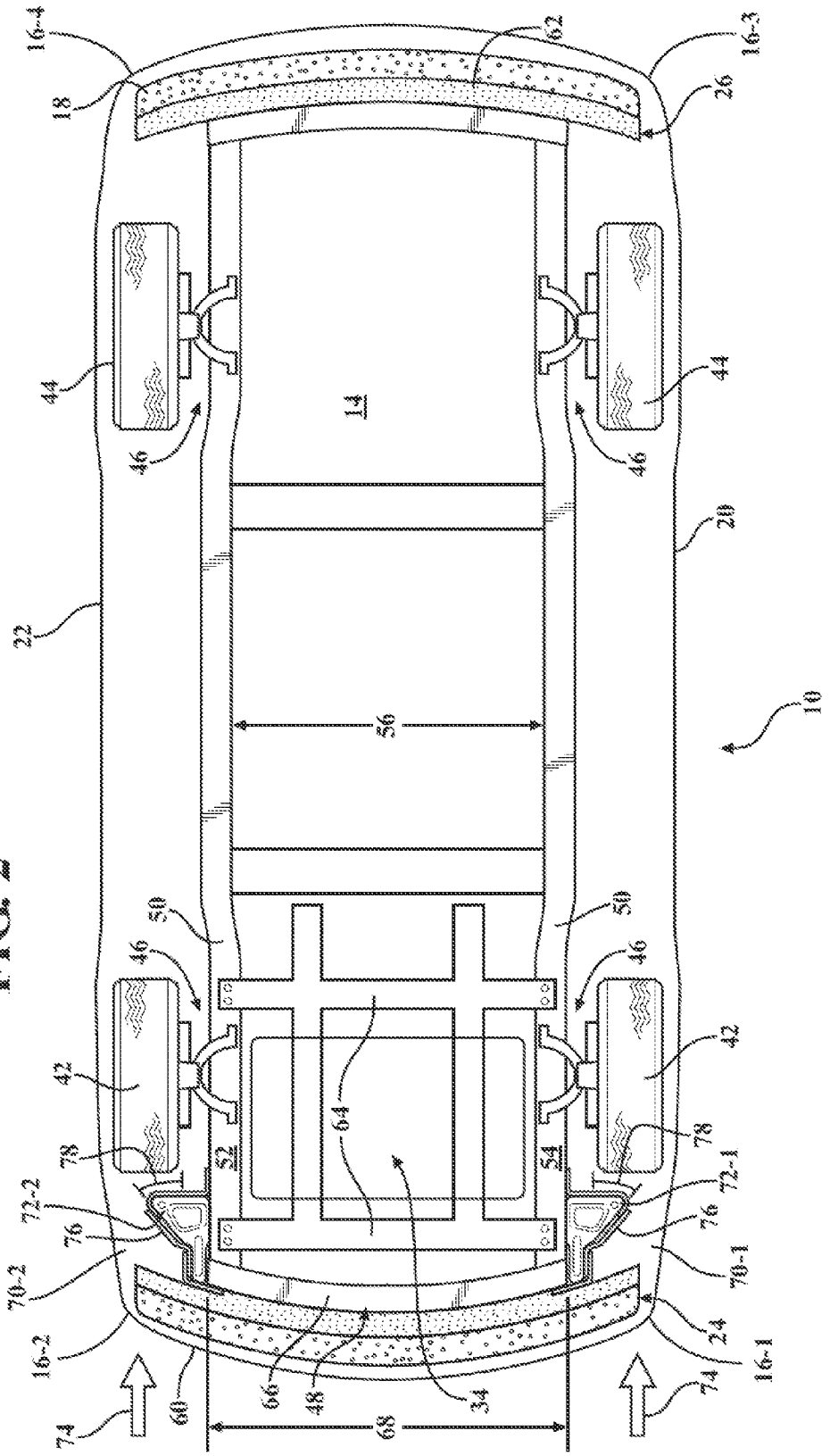
FIG. 3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72-1
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70-2
70-1
16-2
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16-1
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FIG. 2

IMPACT DEFLECTION AND ABSORPTION STRUCTURE

TECHNICAL FIELD

[0001] The invention relates to a vehicle structure for deflecting and absorbing impact energy.

BACKGROUND

[0002] A motor vehicle typically employs a robust frame for supporting the vehicle's body. The more common types of vehicle frames are a full frame, a unibody, and a sub-frame. A full frame is generally a distinct structure that provides a mounting base for the vehicle body, while a unibody is typically formed by integrating frame sections with the vehicle body. A sub-frame is usually a stand-alone structure mounted to the unibody for supporting a specific vehicle subsystem, such as a powerplant.

[0003] Typically, vehicles employ additional structural components, such as bumpers, designed to allow the vehicle to withstand some level of impact without sustaining extensive damage to the vehicle's body or its safety systems. Such additional components are typically tied to the vehicle frame to allow the frame to absorb a significant portion of impact energy and, for occupant protection, route the energy away from the vehicle's passenger or occupant compartment.

SUMMARY

[0004] An impact deflection and absorption structure is disclosed for a vehicle. The vehicle includes a body having a passenger compartment and an under-hood compartment. The impact deflection and absorption structure includes a frame having a frame rail configured to support the vehicle body. The impact deflection and absorption structure also includes a bumper assembly secured to the frame rail. The bumper assembly includes an impact beam arranged substantially transverse to the frame rail and a lateral member secured to the impact beam. The lateral member projects away from the impact beam and is configured to counteract, i.e., redirect, deflect, and/or guide, impact energy that is directed substantially parallel to the frame rail into the frame rail and away from the under-hood compartment and the passenger compartment.

[0005] The lateral member may include an outer surface. The outer surface may be arranged at an angle with respect to the frame rail and configured to transfer the impact energy into the frame rail. Additionally, the outer surface being arranged at an angle with respect to the frame rail may transfer the impact energy into an un-impacted portion of the impact deflection and absorption structure through components of the bumper assembly, for example through the impact beam.

[0006] The angle of the outer surface with respect to the frame rail may be in the range of 10-60 degrees.

[0007] The lateral member may be constructed from steel. The lateral member may also be constructed from aluminum alloy.

[0008] The lateral member may additionally be secured to the frame rail.

[0009] The lateral member may be welded to at least one of the impact beam and the frame rail.

[0010] The lateral member may be fastened to at least one of the impact beam and the frame rail.

[0011] The lateral member may define a hollow space configured to reduce mass of the lateral member.

[0012] The lateral member may be configured as a cantilevered structural member having a width, height, and depth. The depth may have a magnitude that is either substantially equivalent to or greater than the width.

[0013] A vehicle employing the above-described impact deflection and absorption structure is also disclosed.

[0014] The above features and advantages, and other features and advantages of the present disclosure, will be readily apparent from the following detailed description of the embodiment(s) and best mode(s) for carrying out the described invention when taken in connection with the accompanying drawings and appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. **1** is a schematic top view of a vehicle including an impact deflection and absorption structure shown in phantom.

[0016] FIG. **2** is a partial schematic close-up bottom view of the vehicle with impact deflection and absorption structure shown in FIG. **1**.

[0017] FIG. **3** is a partial schematic bottom perspective view of the impact deflection and absorption structure shown in FIG. **2**.

DETAILED DESCRIPTION

[0018] Referring to the drawings, wherein like reference numbers refer to like components, FIG. **1** shows a schematic view of a motor vehicle **10** positioned relative to a road surface **12**. The vehicle **10** includes a vehicle body **14**. The vehicle body **14** defines four body sides. The four body sides include a first or front end **16**, a second or rear end **18**, a right side **20**, and a left side **22**, all of which are characterized by exterior panels or surfaces. As shown, the front end **16** may include a front bumper assembly **24**, while the rear end **18** may include a rear bumper assembly **26**. As defined herein, the bumper assemblies **24** and **26** are inner structures that are covered by exterior panels of the body sides **16**, **18**, **20**, and **22**.

[0019] An outer corner is defined where one of the body sides **16**, **18**, **20**, and **22** joins another body side on the exterior surface of the vehicle body **14**. Specifically, the front end **16** joining the right side **20** defines an outer corner **16-1**, the front end **16** joining the left side **22** defines an outer corner **16-2**, the rear end **18** joining the right side **20** defines an outer corner **16-3**, and the rear end **18** joining the left side **22** defines an outer corner **16-4**. The vehicle body **14** also includes a hood **28** configured to cover at least a portion of the front end **16** to thereby define an under-hood compartment **30**. The vehicle body **14** also defines a passenger or occupant compartment **32** positioned between the under-hood compartment **30** and the rear end **18**. A longitudinal centerline **34** extends through the vehicle body **14**, from the front end **16** to the rear end **18**.

[0020] The under-hood compartment **30** houses a powertrain **36** that is configured to propel the vehicle **10**. As shown in FIG. **1**, the powertrain **36** may include an internal combustion (IC) engine **38** and a transmission **40**. The powertrain **36** may also include one or more motor/generators as well as a fuel cell, neither of which are shown, but a powertrain configuration employing such devices is appreciated by those skilled in the art. The vehicle **10** also includes front wheels **42** and rear wheels **44**. Depending on specific configuration of

the powertrain **36**, power of the engine **38** may be transmitted to the road surface **12** through the front wheels **42**, the rear wheels **44**, or through all the wheels **42** and **44** using a suspension system **46**.

[0021] As shown in phantom in FIG. **1**, the vehicle **10** also includes an impact deflection and absorption structure **48**. As may be seen in FIG. **2**, the structure **48** includes a frame **50** having frame rails **52**, **54** configured to support the vehicle body **14**, the powertrain **36**, and the vehicle suspension system **46**. The frame rails **52**, **54** are positioned apart in the vehicle **10** by a distance **56** and extend longitudinally with respect to the vehicle body **14**. The frame rails **52**, **54** may extend substantially from the front end **16** to the rear end **18** in a full-frame vehicle depicted in FIG. **1**, i.e., for the majority of the length of the vehicle body **14**. As understood by those skilled in the art, in a unibody-type vehicle (not shown), the frame rails **52**, **54** may extend only part of the way from the front end **16** to the rear end **18**, and another set of frame rails may extend longitudinally for some distance to the rear end **18**.

[0022] The structure **48** also includes a bumper assembly **24** secured to the frame rails **52**, **54**. The bumper assembly **24** is substantially enclosed by the front end **16** of the vehicle body **14**, such as by a specifically styled bumper cover **60**. The structure **48** additionally includes the bumper assembly **26** secured to the frame rails **52**, **54** and substantially enclosed by the rear end **18** of the vehicle body **14**, such as by a specifically styled bumper cover **62**. The structure **48** may additionally include intermediate frame rails **64** positioned between the front end **16** and the rear end **18** of the vehicle body **14**. Such intermediate frame rails **64** may be positioned to span the distance between frame rails **52** and **54**, cross-wise or transverse relative to the vehicle body **14** in order to further stiffen the vehicle structure and support the powertrain **36**.

[0023] The bumper assembly **24** includes the impact beam **66** having a length **68**. The impact beam **66** is arranged substantially transverse to the frame rails **52**, **54**, e.g., less than +/−5 degrees. The length **68** and positioning of the impact beam **66** transverse to the frame rails **52**, **54** permits a space **70-1** to be generated on the right side **20** of the front end **16** between the impact beam **66** and the outer corner **16-1**. Similarly, a space **70-2** is generated on the left **22** side of the front end **16** and the outer corner **16-2**. As shown, the bumper assembly **24** also includes two lateral members **72-1** and **72-2**. The lateral members **72-1**, **72-2** are configured to provide a reinforced structure in conjunction with frame rails **52**, **54** and the bumper assembly **24** to withstand the energy of an impact **74** on the vehicle **10** that is offset from the centerline **34**.

[0024] The offset impact **74** is distinct from other types of frontal impact in that the subject impact is directed into the region of the outer corner **16-1** or **16-2**, and the lateral member **72-1** or **72-2**, respectively, counteracts the impact by at least partially filling the spaces **70-1**, **70-2**. The lateral members **72-1** and **72-2** are configured to counteract energy of the impact **74** by redirecting and guiding the force of the impact into the frame rails **52**, **54**. Also, depending on the precise point of contact and the angle of the impact **74** relative to the body **14**, the lateral members **72-1** and **72-2** may also deflect the impact away from the frame rails **52**, **54** and the passenger compartment **32**.

[0025] Each of the lateral members **72-1** and **72-2** may be characterized by a wedge shape having an angled outer surface **76**, as shown in FIG. **2**. As shown, the outer surface **76** is proximate to the front end **16** and is arranged obliquely, i.e., at an angle **78** with respect to the pertinent frame rail **52** or **54**. The angle **78** of the outer surface **76** with respect to the subject frame rail **52** or **54** may be in the range of approximately 10-60 degrees. The lateral members **72-1** and **72-2** may be constructed from a suitable high strength material such as steel or aluminum alloy. As shown, the lateral members **72-1** and **72-2** are configured as cantilevered structural members having a width **80**, height **82**, and depth **84**.

[0026] As shown in FIG. **3**, the width **80** and height **82** are selected to fill the appropriate space **70-1**, **70-2** in the concomitant corner **16-1**, **16-2**, while the depth **84** is selected to appropriately distribute the force of the offset impact **74** into the respective frame rail **52** or **54**. The depth **84** may have a magnitude that is substantially equivalent or greater than the width **80** for structural stability of the subject lateral member **72-1**, **72-2** during the offset impact **74**. In the instant case, the term "substantially" may mean that the magnitude of the depth **84** is at least 80% of the magnitude of the width **80**. As may be seen in FIGS. **2** and **3**, each lateral member **72-1**, **72-2** may also define a hollow space **86**. The hollow space **86** may be provided to reduce mass of the subject lateral member **72-1**, **72-2**.

[0027] One lateral member **72-1** is secured to the impact beam **66** such that the lateral member extends beyond a boundary of the impact beam into the space **70-1** between the impact beam and the outer corner **16-1**. The other lateral member **72-2** is secured to the impact beam **66** such that the lateral member extends beyond a boundary of the impact beam into the space **70-2** between the impact beam and the outer corner **16-2**. Accordingly, each lateral member **72-1** and **72-2** is configured to counteract impact energy that is directed into the respective space **70-1** and **70-2**. Each lateral member **72-1** and **72-2** may additionally be secured to the respective frame rail **52** or **54**. Each lateral member **72-1**, **72-2** may be welded to its respective frame rail **52** or **54** and to the impact beam **66**. Alternatively, each lateral member **72-1**, **72-2** may be fastened to its respective frame rail **52** or **54** and to the impact beam **66** via an appropriate device, such as a rivet or a bolt and a nut. A hybrid welded and fastened lateral member **72-1**, **72-2**, such as the member **72-2** that is shown in FIG. **3**, is also envisioned.

[0028] With resumed reference to FIG. **2**, the vehicle **10** may be subjected to the impact **74** that is directed at or into the respective space **70-1** or **70-2** substantially parallel to the frame rails **52**, **54**. In the absence of the pertinent lateral member **72-1** or **72-2**, such an offset impact may intrude into the under-hood compartment **30**, damage the suspension system **46**, and dislocate the powertrain **36** into the passenger compartment **32**. The lateral members **72-1** and **72-2** may redirect, transfer, or guide the energy of the offset impact **74** into the bumper assembly **24** and the frame rails **52** and/or **54**, and away from the under-hood compartment **30** and the passenger compartment **32**. The outer surface **76** being arranged at the angle **78** with respect to the subject frame rail **52**, **54** may transfer the impact energy into the un-impacted portion of the impact deflection and absorption structure **48**. The un-impacted portion of the impact deflection and absorption structure **48** may include the other, i.e., un-impacted, frame rail **52** or **54**, while the energy may be transferred through components of the bumper assembly **24**, such as through the impact beam **66**. Furthermore, depending on the exact direction and force of the offset impact **74**, the lateral members

72-1 and 72-2 may also deflect the offset impact due to the nature of their wedge shape and the angled outer surface 76.

[0029] The detailed description and the drawings or figures are supportive and descriptive of the invention, but the scope of the invention is defined solely by the claims. While some of the best modes and other embodiments for carrying out the claimed invention have been described in detail, various alternative designs and embodiments exist for practicing the invention defined in the appended claims.

1. A vehicle comprising:

a vehicle body having a first end, two body sides, and a second end, wherein the first end and one of the two body sides defines an outer corner of the vehicle body; and

an impact deflection and absorption structure having:

a frame having a frame rail configured to support the vehicle body; and

a bumper assembly secured to the frame rail and substantially enclosed by the first end of the vehicle body, the bumper assembly having:

an impact beam arranged substantially transverse to the frame rail, such that a space is generated between the impact beam and the outer corner of the vehicle body; and

a lateral member secured to the impact beam such that the lateral member extends into the space between the impact beam and the outer corner of the vehicle body and configured to counteract impact energy that is directed into the space between the impact beam and the outer corner of the vehicle body.

2. The vehicle of claim 1, further comprising a powertrain, wherein:

the vehicle body additionally includes:

a hood configured to cover at least a portion of the first end of the body to thereby define an under-hood compartment, wherein the powertrain is positioned substantially in the under-hood compartment; and

a passenger compartment positioned between the under-hood compartment and the second end; and

the lateral member is additionally configured to redirect the impact energy that is directed at the space between the impact beam and the outer corner of the vehicle body substantially parallel to the frame rail into the frame rail and away from the under-hood compartment and the passenger compartment.

3. The vehicle of claim 2, wherein the lateral member includes an outer surface proximate to the first end of the vehicle body, and wherein the outer surface is arranged at an angle with respect to the frame rail and configured to transfer the impact energy into the frame rail.

4. The vehicle of claim 3, wherein the angle of the outer surface with respect to the frame rail is in the range of 10-60 degrees.

5. The vehicle of claim 1, wherein the lateral member is constructed from steel.

6. The vehicle of claim 1, wherein the lateral member is constructed from aluminum alloy.

7. The vehicle of claim 1, wherein the lateral member is additionally secured to the frame rail.

8. The vehicle of claim 7, wherein the lateral member is welded to at least one of the impact beam and the frame rail.

9. The vehicle of claim 7, wherein the lateral member is fastened to at least one of the impact beam and the frame rail.

10. The vehicle of claim 1, wherein the lateral member defines a hollow space configured to reduce mass of the lateral member.

11. An impact deflection and absorption structure for a vehicle having a vehicle body including a passenger compartment and an under-hood compartment, the impact deflection and absorption structure comprising:

a frame having a frame rail configured to support the vehicle body; and

a bumper assembly secured to the frame rail, the bumper assembly having:

an impact beam arranged substantially transverse to the frame rail; and

a lateral member secured to the impact beam such that the lateral member projects away from the impact beam and is configured to counteract impact energy that is directed substantially parallel to the frame rail into the frame rail and away from the under-hood compartment and the passenger compartment.

12. The impact deflection and absorption structure of claim 11, wherein the lateral member includes an outer surface, and wherein the outer surface is arranged at an angle with respect to the frame rail and configured to transfer the impact energy into the frame rail.

13. The impact deflection and absorption structure of claim 12, wherein the angle of the outer surface with respect to the frame rail is in the range of 10-60 degrees.

14. The impact deflection and absorption structure of claim 11, wherein the lateral member is constructed from steel.

15. The impact deflection and absorption structure of claim 11, wherein the lateral member is constructed from aluminum alloy.

16. The impact deflection and absorption structure of claim 11, wherein the lateral member is additionally secured to the frame rail.

17. The impact deflection and absorption structure of claim 16, wherein the lateral member is welded to at least one of the impact beam and the frame rail.

18. The impact deflection and absorption structure of claim 16, wherein the lateral member is fastened to at least one of the impact beam and the frame rail.

19. The impact deflection and absorption structure of claim 11, wherein the lateral member defines a hollow space configured to reduce mass of the lateral member.

20. The impact deflection and absorption structure of claim 11, wherein the lateral member is configured as a cantilevered structural member having a width, height, and depth, and wherein the depth has a magnitude that is one of substantially equivalent and greater than the width.

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