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ENERGY ABSORBER

Abstract

An energy absorber includes a connecting portion provided between a protrusion and a fixing portion, and a part or all of the connecting portion is an inclined portion. When an external force is applied in a direction inclined with respect to an axis of the protrusion, the inclined portion is deformed, and the protrusion changes in direction so that its axis is aligned with the external force, and the energy absorber is crushed to absorb energy.

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Background/Summary

FIELD OF THE INVENTION

[0001] The present invention relates to an energy absorber disposed between a door panel and a door trim.

[0002] A door trim is a lining member that is provided on a passenger compartment side of a door panel. There is known an energy absorber capable of enhancing occupant protection and disposed between the door trim and the door panel.

[0003] Various shapes of energy absorbers of this type have been proposed (for example, JP 2022-140743 A).

[0004] Patent Document 1 (JP 2022-140743 A) will be described with reference to the following drawings. FIG. **10**A is a partially cross-sectional view of a vehicle with a conventional energy absorber. As illustrated in FIG. **10**A, a seat **102** for an occupant to sit thereon is disposed in a passenger compartment **101** of a vehicle **100**. A door **110** disposed beside the seat **102** includes a door panel **111** having a hollow structure, a window glass **112**, and a door trim **113** serving as an interior lining member.

[0005] Then, an energy absorber **120** is provided between the door trim **113** and the door panel **111**. The energy absorber **120** absorbs the energy by crushing. When a large force is applied from outside the vehicle toward the passenger compartment **101**, the door panel **111** deforms and enters the passenger compartment **101**. Then, the door trim **113** hits the seat **102**, and the energy absorber **120** is crushed. Due to this crushing, a large force is reduced, and the influence on the occupant sitting on the seat **102** is reduced.

[0006] FIG. **10**B is an enlarged view of a part b of FIG. **10**A. As shown in FIG. **10**B, the energy absorber **120** includes a flange **121** which is fixed to the door trim **113**, a large diameter cylindrical portion **122** which extends from the flange **121** toward the door panel **111**, a large diameter doughnut plate **123** which is provided at the tip of the large diameter cylindrical portion **122**, a medium diameter cylindrical portion **124** which extends from the edge of the hole of the large diameter doughnut plate **123** toward the door panel **111**, a medium diameter doughnut plate **125** which is provided at the tip of the medium diameter cylindrical portion **124**, a small diameter cylindrical portion **126** which extends from the edge of the hole of the medium diameter doughnut plate **125** toward the door panel **111**, and a lid **127** which blocks the tip opening of the small diameter cylindrical portion **126**. The energy absorber **120** has a stepped shape in cross section.

[0007] FIG. **10**C is an operational view of the conventional energy absorber **120**. Since the energy absorber **120** has a stepped shape, the energy absorber is easily crushed as shown in FIG. **10**C. When considering the crushing, since the large diameter doughnut plate **123** and the medium diameter doughnut plate **125** are perpendicular to an axis **128** of action of an external force, they are easily bent. Therefore, the energy absorber **120** is crushed stably as a whole. On the other hand, the energy absorber **120** absorbs energy gently, and the energy absorbing performance is reduced.

[0008] There may be a demand for improving the energy absorbing performance of the energy absorber **120**. Therefore, various structures having higher energy absorbing performance than that of Patent Document 1 have been proposed (for example, JP 2015-205671 A).

[0009] Patent Document 2 will be described with reference to the following drawings. FIG. **11** is a cross-sectional view of another conventional energy absorber. As shown in FIG. **11**, an energy absorber **130** includes a flange **131**, a tapered cylindrical portion **132** which extends from the flange **131** and has a tapered shape, and a lid **133** which blocks the tip opening of the tapered cylindrical portion **132**.

[0010] In such an energy absorber **130**, since the large diameter doughnut plate **123** and the medium diameter doughnut plate **125** shown in FIG. **10**B do not exist, the energy absorbing performance increases as the rigidity increases.

[0011] That is, when an external force F**1** is applied along an axis **134** of the tapered cylindrical portion **132**, the tapered cylindrical portion **132** is crushed to exhibit a desired energy absorbing

performance. However, when an external force F**2** is applied in a direction inclined with respect to the axis **134** of the tapered cylindrical portion **132**, an angles θa and θb do not change easily. Accordingly, since the tapered cylindrical portion **132** is distorted and crushed, the energy absorbing performance decreases, leading to instability.

[0012] Incidentally, in the case of a side collision, in which a large external force is applied to a vehicle from the side, the frequency of the external force F**2** is higher than that of the external force F**1**. Therefore, there is a demand for an energy absorber that can stably absorb energies that are input obliquely.

[0013] An object of the present invention is to provide an energy absorber capable of stably absorbing an energy that is input obliquely.

SUMMARY

[0014] A disclosed energy absorber provided between a vehicle door panel and a door trim covering the door panel from a passenger compartment and serving as an interior part of the passenger compartment includes: a protrusion which protrudes from the door trim side toward the door panel side and has a tip capable of receiving the door panel and a base end spaced apart from a rear surface of the door trim; and a fixing portion which is provided on an outer periphery of the base end of the protrusion and is fixable to the door trim, wherein the base end of the protrusion and the fixing portion are connected through an annular connecting portion, and wherein the connecting portion has an inclined portion which approaches the door trim as it moves radially inward with respect to an axis of the protrusion.

[0015] The present invention provides an energy absorber that can stably absorb an energy that is input obliquely.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] FIG. **1**A is a cross-sectional view of an energy absorber according to a first embodiment, and FIG. **1**B is a diagram illustrating a form in which the energy absorber is attached to a vehicle.

[0017] FIG. **2**A is a diagram illustrating an operation of an energy absorber according to a comparative example, and FIGS. **2**B and **2**C are diagrams illustrating an effect of the energy absorber according to the embodiment.

[0018] FIG. **3** is a cross-sectional view of an energy absorber according to a second embodiment.

[0019] FIG. **4** is a cross-sectional view of an energy absorber according to a third embodiment.

[0020] FIG. **5** is a cross-sectional view of an energy absorber according to a fourth embodiment.

[0021] FIG. **6** is a cross-sectional view of an energy absorber according to a fifth embodiment.

[0022] FIG. **7** is a cross-sectional view of an energy absorber according to a sixth embodiment.

[0023] FIG. **8** is a cross-sectional view of an energy absorber according to a seventh embodiment.

[0024] FIG. **9** is a graph illustrating an energy absorbing amount.

[0025] FIG. **10**A is a partially cross-sectional view of a vehicle with a conventional energy absorber, FIG. **10**B is an enlarged view of a part b of FIG. **10**A, and FIG. **10**C is an operational view of the conventional energy absorber.

[0026] FIG. **11** is a cross-sectional view of another conventional energy absorber.

DETAILED DESCRIPTION

[0027] Embodiments of the present invention will be described below with reference to the accompanying drawings. Furthermore, the drawings should be viewed in the direction of the symbols.

EMBODIMENTS

Energy Absorber According to First Embodiment

[0028] As illustrated in FIG. **1**A, an energy absorber **10** includes a pointed tapered protrusion **11**, a

fixing portion **14** fixed to a door trim **12** by a fastener **13** such as a bolt, and a connecting portion **15** connecting the fixing portion **14** and a base end **11***a* of the protrusion **11**. The connecting portion **15** has an annular shape to surround the base end **11***a* of the protrusion **11**.

[0029] Then, the connecting portion **15** has an inclined portion **16** that approaches the door trim **12** as it moves radially inward with respect to an axis **11***b* of the protrusion **11**. This inclined portion **16** may constitute all or a part of the connecting portion **15**.

[0030] Furthermore, since the connecting portion **15** has an annular shape, the inclined portion **16** also has an annular shape. Due to the annular shape, the inclined portion **16** has an outer peripheral portion **16***a* and an inner peripheral portion **16***b*. In other words, the inclined portion **16** is inclined so that the inner peripheral portion **16***b* approaches the door trim **12** along the axis **11***b* of the protrusion **11** relative to the outer peripheral portion **16***a*.

[0031] The energy absorber **10** is basically made of resin, but may be made of light metal such as an aluminum alloy or a magnesium alloy.

[0032] The fastener **13** is basically a bolt, but may be a screw, a headed pin, a tapping screw, a rivet, or an adhesive.

[0033] FIG. **1**B illustrates the energy absorber **10** with such a structure attached to a vehicle door.

[0034] As illustrated in FIG. **1**B, the energy absorber **10** is provided between a door panel **18** and the door trim **12** which covers the door panel **18** from the passenger compartment side (FIG. **10**, reference numeral **101**) and serves as an interior part of the passenger compartment.

[0035] The protrusion **11** of the energy absorber **10** protrudes from the door trim **12** toward the door panel **18** and has a tip capable of receiving the door panel **18** and the base end **11***a* spaced apart from a rear surface **12***a* of the door trim **12** by δ**1**.

[0036] The fixing portion **14** of the energy absorber **10** is provided on the outer periphery of the base end **11***a* of the protrusion **11**, and is fixable to the door trim **12**.

[0037] The connecting portion **15** of the energy absorber **10** is an annular portion which connects the base end **11***a* of the protrusion **11** and the fixing portion **14**, and has the inclined portion **16**.

[0038] The inclined portion **16** included in the connecting portion **15** is inclined so as to approach the door trim as it moves radially inward with respect to the axis **11***b* of the protrusion **11**.

[0039] Furthermore, the inclined portion **16** is also a portion inclined so that the inner peripheral portion **16***b* approaches the door trim **12** along the axis **11***b* of the protrusion **11** relative to the outer peripheral portion **16***a*.

[0040] The operation of the energy absorber **10** with the above-described configuration will be described with reference to FIGS. **2**A to **2**C. Furthermore, FIG. **2**A is a reprint of FIG. **11**.

[0041] In FIG. **2**A, the angles formed between the flange **131** and the tapered cylindrical portion **132** are represented as θa and θb.

[0042] Since the conventional energy absorber **130** has a high rigidity, θa and θb do not change easily even when subjected to an oblique external force F**2**. As a result, the energy absorber **130** is not crushed in a predetermined manner, but is crushed in a distorted manner. In a distorted collapsing manner, the energy absorbing performance is reduced and the structure becomes unstable.

[0043] Additionally, in the embodiment illustrated in FIG. **2**B, the inclined portion **16** is included in the connecting portion **15** that connects the protrusion **11** and the fixing portion **14**. The angles formed between the inclined portion **16** and the protrusion **11** are represented as θ**1** and θ**2**.

[0044] Since the intersection of the inclined portion **16** and the protrusion **11** forms a V-shaped cross section, the interior angles θ**1** and θ**2** of this V shape change with a smaller force than the angles θa and θb illustrated in FIG. **2**A.

[0045] Specifically, the angle θ**1** becomes smaller as the base end **11***a* in the vicinity of the angle θ**1** approaches the door trim **12**. On the other hand, the base end **11***a* in the vicinity of the angle θ**2** is displaced less, and the angle θ**2** becomes larger.

[0046] As a result, as illustrated in FIG. **2**C, the protrusion **11** is inclined so that the axis **11***b* is

aligned with the force F**2**. Thereafter, the force F**2** causes the energy absorber **10** to be crushed in a predetermined manner along the axis **11***b*.

[0047] Furthermore, the above-described action is smoothly performed by the base end **11***a* spaced apart from the rear surface of the door trim **12** by δ**1**.

[0048] Therefore, the energy absorber **10** that can stably absorb energies that are input obliquely is provided due to the presence of the inclined portion **16** and the distance **81**.

[0049] Next, modified examples of the present invention will be described in order with reference to FIGS. **3** to **6**.

Energy Absorber According to Second Embodiment

[0050] The form of the energy absorber **10** according to a second embodiment will be described with reference to FIG. **3**.

[0051] The energy absorber **10** illustrated in FIG. **3** is different from that of FIG. **1**B in that the connecting portion **15** is provided with a second inclined portion **21** in addition to the inclined portion **16**. Since the other elements are not changed, detailed description thereof will be omitted by using the reference numerals of FIG. **1**B.

[0052] As illustrated in FIG. **3**, the second inclined portion **21** is disposed at a portion that connects the inclined portion **16** and the fixing portion **14**. Then, the second inclined portion **21** is inclined to move away from the door trim **12** as it moves radially inward with respect to the axis **11***b* of the protrusion **11**.

[0053] That is, the second inclined portion **21** has an outer peripheral portion **21***a* and an inner peripheral portion **21***b*, and the inner peripheral portion **21***b* is inclined along the axis **11***b* of the protrusion **11** to move away from the door trim **12** relative to the outer peripheral portion **21***a*.

Operation and Effect of Second Embodiment

[0054] As obvious from FIG. **3**, the protrusion **11** and the inclined portion **16** form a V-shaped cross section, and the inclined portion **16** and the second inclined portion **21** form a second V-shaped cross section. As a result, the deformability at the connection portion **15** is doubled. When the deformability is doubled, the change from FIGS. **2**B to **2**C occurs more quickly, and the effect of the present invention is more reliably achieved.

Energy Absorber According to Third Embodiment

[0055] The form of the energy absorber **10** according to a third embodiment will be described with reference to FIG. **4**.

[0056] The energy absorber **10** illustrated in FIG. **4** is different from that of FIG. **3** in that the distance between the rear surface **12***a* of the door trim **12** and the tip of the base end **11***a* is set to δ**2** larger than δ**1**. Since the other elements are not changed, detailed description thereof will be omitted by using the reference numerals of FIG. **3**.

[0057] That is, the rear surface **12***a* of the door trim **12** has a base portion **23** that protrudes toward the door panel **18**. The fixing portion **14** is fixable to the base portion **23**. Then, the base end **11***a* of the protrusion **11** is located at the same position as the tip of the base portion **23** with respect to the extension direction of the axis **11***b* of the protrusion **11**.

Operation and Effect of Third Embodiment

[0058] Since the distance between the rear surface **12***a* of the door trim **12** and the tip of the base end **11***a* is set to a sufficiently large value δ**2**, the base end **11***a* is less likely to come into contact with the rear surface **12***a* of the door trim **12**, and the effect of the present invention can be more reliably achieved.

[0059] In addition, since the base end **11***a* of the protrusion **11** is located at the same position as the tip of the base portion **23**, the tip of the fixing portion **14** and the base end **11***a* are aligned on the same plane. Since they are aligned on the same plane, there is an advantage that the design of the die is easier for both resin molding dies and press molding dies.

Energy Absorber According to Fourth Embodiment

[0060] The form of the energy absorber **10** according to a fourth embodiment will be described

with reference to FIG. **5**.

[0061] The energy absorber **10** illustrated in FIG. **5** is different from that of FIG. **3** in that the distance between the rear surface of the door trim **12** and the tip of the base end **11***a* is set to δ**3** smaller than δ**1**. Since the other elements are not changed, detailed description thereof will be omitted by using the reference numerals of FIG. **3**.

[0062] That is, the rear surface of the door trim **12** has the base portion **23** protruding toward the door panel **18** and the base end **11***a* of the protrusion **11** is closer to the door trim **12** than the tip of the base **23** with respect to the extension direction of the axis **11***b* of the protrusion **11**.

Operation and Effect of Fourth Embodiment

[0063] Although there is a risk that the base end **11***a* may come into contact with the rear surface of the door trim **12**, the distance L between the door panel **18** and the door trim **12** can be reduced. If the distance L is small, the vehicle door can be made compact.

Energy Absorber According to Fifth Embodiment

[0064] The form of the energy absorber **10** according to a fifth embodiment will be described with reference to FIG. **6**.

[0065] The energy absorber **10** illustrated in FIG. **6** is different from that of FIG. **5** in that a plurality of elongated holes **25** extending along the axis **11***b* are provided in the protrusion **11**. Since the other elements are not changed, detailed description thereof will be omitted by using the reference numerals of FIG. **5**.

[0066] Although it is recommended that three elongated holes **25** are provided at a pitch of 120° along the circumference, four elongated holes **25** may be provided at a pitch of 90° along the circumference, and the number of holes is optional.

Operation and Effect of Fifth Embodiment

[0067] As will be described in detail later with reference to FIG. **9**, the load during energy absorption can be suppressed to an appropriate value.

Energy Absorber According to Sixth Embodiment

[0068] The form of the energy absorber **10** according to a sixth embodiment will be described with reference to FIG. **7**.

[0069] The energy absorber **10** illustrated in FIG. **7** is different from that of FIG. **6** in the set range of the elongated hole **25**. Specifically, the elongated hole **25** extends to the base end **11***a* of the protrusion **11**. Since the other elements are not changed, detailed description thereof will be omitted by using the reference numerals of FIG. **6**.

Operation and Effect of Sixth Embodiment

[0070] Compared with the fifth embodiment, undercut processing of the mold for the energy absorber **10** is not necessary.

Energy Absorber According to Seventh Embodiment

[0071] The form of the energy absorber **10** according to a seventh embodiment will be described with reference to FIG. **8**.

[0072] The energy absorber **10** illustrated in FIG. **8** is different from that of FIG. **5** in that a second connecting portion **27** is interposed between the base end **11***a* of the protrusion **11** and the connecting portion **15**. Since the other elements are not changed, detailed description thereof will be omitted by using the reference numerals of FIG. **5**.

[0073] The second connecting portion **27** is an annular portion extending in parallel to the rear surface of the door trim **12**, that is, a portion extending perpendicular to the axis **11***b*. Since the second connecting portion **27** is perpendicular to the axis **11***b*, the second connecting portion easily bends in a direction along the axis **11***b* when subjected to an external force. Therefore, the energy load is reduced.

Operation and Effect of Seventh Embodiment

[0074] As will be described in detail later with reference to FIG. **9**, the load during energy absorption can be suppressed to an appropriate value.

Energy Absorbing Performance
[0075] FIG. **9** is a graph in which the horizontal axis represents the stroke, that is, the crush allowance, the vertical axis represents the force applied from the outside, that is, the energy load, and the shaded area represents the energy absorbing amount.
[0076] The first to fourth embodiments are illustrated by solid lines, and the fifth to seventh embodiments are illustrated by dashed lines.
[0077] The solid line and the dashed line have roughly the same rise, but the load after the rise (load roughly parallel to the horizontal axis) is smaller for the dashed line.
[0078] Therefore, in the fifth to seventh embodiments, the load during energy absorption can be suppressed to an appropriate value compared with the first to fourth embodiments.

Claims

1. A energy absorber provided between a vehicle door panel and a door trim covering the door panel from a passenger compartment and serving as an interior part of the passenger compartment, comprising: a protrusion which protrudes from the door trim side toward the door panel side and has a tip capable of receiving the door panel and a base end spaced apart from a rear surface of the door trim; and a fixing portion which is provided on an outer periphery of the base end of the protrusion and is fixable to the door trim, wherein the base end of the protrusion and the fixing portion are connected through an annular connecting portion, and wherein the connecting portion has an inclined portion which approaches the door trim as it moves radially inward with respect to an axis of the protrusion.
2. The energy absorber according to claim 1, wherein the connecting portion has a second inclined portion which is spaced apart from the door trim as it moves radially inward with respect to the axis of the protrusion, and wherein the second inclined portion connects the inclined portion and the fixing portion.
3. The energy absorber according to claim 2, wherein the rear surface of the door trim has a base portion protruding toward the door panel side, wherein the fixing portion is fixable to the base portion, and wherein the base end of the protrusion with respect to an extension direction of the axis of the protrusion is located at the same position as a tip of the base portion.
4. The energy absorber according to claim 2, wherein the rear surface of the door trim has a base portion protruding toward the door panel side, and wherein the base end of the protrusion with respect to the extension direction of the axis of the protrusion is closer to the door trim than a tip of the base portion.
5. The energy absorber according to claim 3, wherein a plurality of holes extending along the axis are provided in the protrusion.
6. The energy absorber according to claim 5, wherein the hole extends to the base end of the protrusion.
7. The energy absorber according to claim 4, wherein a plurality of holes extending along the axis are provided in the protrusion.
8. The energy absorber according to claim 7, wherein the hole extends to the base end of the protrusion.
9. The energy absorber according to claim 3, wherein a second connecting portion is interposed between the base end of the protrusion and the connecting portion, and wherein the second connecting portion has an annular shape and extends in parallel to the rear surface of the door trim.
10. The energy absorber according to claim 4, wherein a second connecting portion is interposed between the base end of the protrusion and the connecting portion, and wherein the second connecting portion has an annular shape and extends in parallel to the rear surface of the door trim.