CLAIMS

1. A collision detection device for detecting a collision of a vehicle, in particular, a rail vehicle, with a collision partner, comprising

- a collision unit (110),
- a mounting device (109) for mounting said collision detection device to said vehicle, and
- a sensor device (111);
- said collision unit (110) comprising at least one collision element (110.1) for contacting said collision partner in a collision event;
- said sensor device (111) being configured to generate a first collision signal representative of a first threshold collision event having a definable first threshold severity as a function of a first threshold relative deflection of said collision unit (110) relative to said mounting device (109) from a neutral position during said first threshold collision event;
- said collision unit (110) being coupled to said mounting device (109) via a resetting unit (114) and via a guide element (109.2), in particular a hinge element, defining a motion of said collision element (110.1) during said collision event;
- said resetting unit (114) being configured to undergo, during said threshold collision event, a first elastic resetting unit deflection from a neutral resetting unit position;

characterized in that

- said resetting unit (114) is configured to undergo, during a second threshold collision event having a second threshold severity greater than said first threshold severity, a second elastic resetting unit deflection, said second elastic resetting unit deflection being larger than said first elastic resetting unit deflection;
- said sensor device (111) is configured to generate a second threshold collision signal representative of said second threshold collision event as a function of a second threshold relative deflection of said collision unit (110) relative to said mounting device (109) from said neutral position during said second threshold collision event; and

- said resetting unit (114) being configured to elastically reset, in a resetting action, from said second elastic resetting unit deflection to substantially said neutral resetting unit position upon removal of said collision partner, thereby resetting said collision unit (110) to substantially said neutral position.

2. The collision detection device according to claim 1, wherein

- said resetting unit (114) is a damping unit comprising at least one damping element damping said relative deflection of said collision unit (110);

and/or

- said resetting unit (114) comprises at least one resetting element in the form of a spring element (114.1, 114.2) for generating a resetting force during said resetting action;

and/or

- said resetting unit (114) comprises at least one elastic all-metal cushion element (114.1, 114.2) for generating a resetting force during said resetting action;

and/or

- said resetting unit (114) comprises at least one elastic polymer element (114.1, 114.2), in particular a rubber element, for generating a resetting force during said resetting action;

and/or

- said resetting unit (114) comprises at least one layered metal polymer unit (114.1, 114.2), in particular a layered metal rubber unit, for generating a resetting force during said resetting action.

3. The collision detection device according to one of claims 1 or 2, wherein

- said resetting unit (114) comprises a first hard stop element (114.3), a second hard stop element (114.4) and a resetting element (114.1);
- said first hard stop element (114.3) being substantially rigidly connected to said collision unit (110),
- said second hard stop element (114.4) being substantially rigidly connected to said mounting device (109)

- said first hard stop element (114.3) and said second hard stop element (114.4) being shifted with respect to each other during a first deflection of said collision element (110.1) in a first direction
- said resetting element (114.1, 114.2) being located between said first hard stop element (114.3) and said second hard stop element (114.4) and being deflected due to said shift between said first hard stop element (114.3) and said second hard stop element (114.4);
- said resetting unit (114), in particular, comprising a guide element (114.4) guiding said resetting element (114.1) during said deflection;
- said guide element (114.4), in particular being a linear guide element and/or a rod element;
- said guide element (114.4), in particular being substantially rigidly connected to said mounting device (109) or said collision unit (110).

4. The collision detection device according to claim 3, wherein

- said resetting unit (114) comprises a third hard stop element (114.6) and a further resetting element (114.2);
- said third hard stop element (114.6) being substantially rigidly connected to said collision unit (110) or to said mounting device (109)
- said third hard stop element (114.6) and a counter hard stop element (114.3) being shifted with respect to each other in a second direction opposite to said first direction during a second deflection of said collision element (110.1), said counter hard stop element (114.3) being said first hard stop element (114.3) or said second hard stop element (114.4);
- said further resetting element (114.1, 114.2) being located between said counter hard stop element (114.3) and said third hard stop element (114.6) and being deflected due to said shift between said counter hard stop element (114.3) and said third hard stop element (114.6);
- said resetting unit (114), in particular, comprising a guide element (114.4) guiding said further resetting element (114.1, 114.2) during said deflection;
- said guide element (114.4), in particular being a linear guide element and/or a rod element;

- said guide element (114.4), in particular being substantially rigidly connected to said mounting device (109) or said collision unit (110).

5. The collision detection device according to claim 4, wherein

- said third hard stop element (114.6) has a mechanical connection to said mounting device (109);
- said third hard stop element (114.6) and/or said mechanical connection being configured to fail at a definable threshold shift between said counter hard stop element (114.3) and said third hard stop element (114.6) in said second direction to substantially liberate motion of said collision element (110.1);
- said mechanical connection, in particular, including said guide element (114.4);
- said third hard stop element (114.6), in particular, comprising a disc shaped element connected to said guide element (114.4).

6. The collision detection device according to one of claims 1 to 5, wherein

- said collision unit (110) is configured to undergo a deflection from said neutral position in a first direction upon a first type of collision event and to undergo a deflection from said neutral position in a second direction opposite to said first direction upon a second type of collision event;
- said resetting unit (114) comprising at least one first resetting element (114.1, 114.2) for generating a resetting force during said resetting action in said second direction upon said first type of collision event;
- said resetting unit (114) comprising at least one second resetting element (114.1, 114.2) for generating a resetting force during said resetting action in said first direction upon said second type of collision event;
- said first type of collision event, in particular, being a collision with a collision partner located on a track travelled by said vehicle;
- said second type of collision event, in particular, being a collision with a part of said track during a derailment event of said vehicle.

7. The collision detection device according to one of claims 1 to 6, wherein,

- said collision unit (110) is configured to undergo, during said first threshold collision event, a first collision unit deflection from said neutral position and to undergo, during said second threshold collision event, a second collision unit deflection, said second collision unit deflection being larger than said first collision unit deflection;
- said collision unit (110) comprising a collision energy absorbing plastic deformation part (110.3) for reducing collision loads introduced into said vehicle;
- said plastic deformation part (110.3) being configured to undergo, in a third collision event having a severity greater than said second threshold severity, a defined locally concentrated plastic deformation;
- said plastic deformation part (110.3), in particular, being a structurally weakened section and/or a recessed section of said collision unit (110);
- said mounting device (109), in particular, comprising a hard stop element limiting a reversible deflection of said collision unit (110) to a limit deflection, said limit deflection being substantially equal to or greater than said second collision unit (110) deflection.

8. The collision detection device according to one of claims 1 to 7, wherein,

- said sensor device (111) is configured to generate a third threshold collision signal representative of a third threshold collision event as a function of a third threshold relative deflection of said collision unit (110) relative to said mounting device (109) from said neutral position during a third collision event having a severity larger than said second threshold severity;

and/or

- said sensor device (111) is configured to generate, in a collision event of a first type of collision event, a first collision type signal representative of said first type of collision event and to generate, in a collision event of a second type of collision event, a second collision type signal representative of said second type of collision event, said first type of collision event, in particular, being a collision with a collision partner (107) located on a track (108) travelled by said vehicle and said second type of collision event, in particular, being a collision with a part of said track (108) during a derailment event of said vehicle, said collision unit (110), in particular,

being configured to undergo a deflection from said neutral position in a first direction upon said first type of collision event and to undergo a deflection from said neutral position in a second direction opposite to said first direction upon said second type of collision event.

and/or

- said sensor device (111) comprises an inductive sensor unit (111.1) and/or a capacitive sensor unit and/or a contactless sensor unit (111.1)

and/or

- said sensor device (111) comprises an indicator element (111.2) and a sensor element (111.3), said indicator element (111.2) cooperating with said sensor element (111.3) and being connected to and deflected with said collision element (110.1) in an collision event.

9. A vehicle unit, in particular a rail vehicle unit, comprising a running gear (103) and at least one collision detection device (102) according to one of claims 1 to 8 mounted in the area of said running gear (103) via said mounting device (109), said at least one collision detection device (102), in particular, being mounted to said running gear (103) or to a wagon body (101.1) supported on said running gear (103).

10. A method of detecting a collision of a vehicle, in particular, a rail vehicle, with a collision partner, comprising

- coupling a collision element (110.1) to a mounting device (109) via a resetting unit (114) and via a guide element (109.2), in particular a hinge element, defining a motion of said collision element (110.1) during a collision event with said collision partner (107, 108);
- generating a first collision signal representative of a first threshold collision event having a definable first threshold severity as a function of a first threshold relative deflection of said collision element (110.1) relative to said mounting device (109) from a neutral position during said first threshold collision event;
- said resetting unit (114), during said first threshold collision event, undergoing a first elastic resetting unit deflection from a neutral resetting unit position;

characterized in that

- said resetting unit (114), during a second threshold collision event having a second threshold severity greater than said first threshold severity, undergoes a second elastic resetting unit deflection, said second elastic resetting unit deflection being larger than said first elastic resetting unit deflection;
- a second threshold collision signal representative of said second threshold collision event is generated as a function of a second threshold relative deflection of said collision unit (110) relative to said mounting device (109) from said neutral position during said second threshold collision event; and
- said resetting unit (114), in a resetting action upon removal of said collision partner (107, 108), elastically resetting from said second elastic resetting unit deflection to substantially said neutral resetting unit position, thereby resetting said collision unit (110) to substantially said neutral position.

11. The method according to claim 10, wherein

- said resetting unit (114) is damping said relative deflection of said collision unit (110);

and/or

- at least one spring element (114.1, 114.2) of said resetting unit (114) is generating a resetting force during said resetting action;

and/or

- at least one elastic all-metal cushion element (114.1, 114.2) of said resetting unit (114) is generating a resetting force during said resetting action;

and/or

- at least one elastic polymer element (114.1, 114.2), in particular a rubber element, of said resetting unit (114) is generating a resetting force during said resetting action;

and/or

- at least one layered metal polymer unit, in particular a layered metal rubber unit, of said resetting unit (114) generates a resetting force during said resetting action.

12. The method according to one of claims 10 or 11, wherein

- a resetting element (114.1, 114.2) of said resetting unit (114) is located between a first hard stop element (114.3) and a second hard stop element (114.4), said resetting element (114.1, 114.2), during a first deflection of said collision element (110.1), being deflected due to a shift between said first hard stop element (114.3) and said second hard stop element (114.4) in a first direction,
- a further resetting element (114.1, 114.2) of said resetting unit (114), in particular, being located between a counter hard stop element (114.3) and a third hard stop element (114.6), said further resetting element (114.1, 114.2), during a second deflection of said collision element (110.1), being deflected due to a shift between said counter hard stop element (114.3) and said third hard stop element (114.6) in a second direction opposite to said first direction;
- said resetting element (114.1, 114.2) and/or said further resetting element (114.1, 114.2), in particular, being guided during said deflection by a guide element (114.4), in particular by a linear guide element and/or a rod element;
- said third hard stop element (114.6) or a mechanical connection of said third hard stop element (114.6) to said mounting device (109), in particular, failing at a definable threshold shift between said counter hard stop element (114.3) and said third hard stop element (114.6) in said second direction to substantially liberate motion of said collision element (110.1).

13. The method according to one of claims 10 to 12, wherein

- said collision unit (110) undergoes a deflection from said neutral position in a first direction upon a first type of collision event and undergoes a deflection from said neutral position in a second direction opposite to said first direction upon a second type of collision event;
- a resetting force is generated during said resetting action in said second direction upon said first type of collision event;
- a resetting force is generated during said resetting action in said first direction upon said second type of collision event;
- said first type of collision event, in particular, being a collision with a collision partner (107, 108) located on a track travelled by said vehicle;

- said second type of collision event, in particular, being a collision with a part of said track during a derailment event of said vehicle.

14. The method according to one of claims 10 to 13, wherein,

- said collision unit (110), during said first threshold collision event, undergoes a first collision unit deflection from said neutral position and, during said second threshold collision event, undergoes a second collision unit deflection, said second collision unit deflection being larger than said first collision unit deflection;
- said collision unit (110) comprising a collision energy absorbing plastic deformation part (110.3) for reducing collision loads introduced into said vehicle;
- a plastic deformation part (110.3), in a third collision event having a severity greater than said second threshold severity, undergoes a defined locally concentrated plastic deformation;
- said plastic deformation part (110.3), in particular, being a structurally weakened section and/or a recessed section of said collision unit (110);
- a hard stop element, in particular, limiting a reversible deflection of said collision unit (110) to a limit deflection, said limit deflection being substantially equal to or greater than said second collision unit deflection.

15. The method according to one of claims 10 to 14, wherein,

- a third threshold collision signal representative of a third threshold collision event is generated as a function of a third threshold relative deflection of said collision unit (110) relative to said mounting device (109) from said neutral position during a third collision event having a severity larger than said second threshold severity;

and/or,

- in a collision event of a first type of collision event, a first collision type signal representative of said first type of collision event is generated and, in a collision event of a second type of collision event, a second collision type signal representative of said second type of collision event is generated, said first type of collision event, in particular, being a collision with a collision partner (107, 108) located on a track travelled by said vehicle and said second type of collision event, in particular, being a collision with a part of said track during a derailment event of said vehicle, said collision unit (110), in particular, undergoing a deflection from

said neutral position in a first direction upon said first type of collision event and undergoing a deflection from said neutral position in a second direction opposite to said first direction upon said second type of collision event;

and/or

- said collision signal is generated using an inductive sensor unit and/or a capacitive sensor unit and/or a contactless sensor unit.

and/or

- an indicator element cooperates with a sensor element to generate said collision signal, said indicator element and being connected to and deflected with said collision element (110.1) in an collision event.

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