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Collision detection in a vehicle

The invention relates to a detection device for detecting a collision of a vehicle, in particular a railway vehicle, with a collision partner. The detection device comprises a mount for connecting the detection device to the vehicle, at least one collision unit and at least one
5 sensor device. The collision unit comprises at least one collision element for making contact with the collision partner and is mechanically connected to the mount. The at least one sensor is designed to generate a collision signal as a result of a relative movement between the collision unit and the mount. The invention also relates to a vehicle, in particular a railway vehicle, with a vehicle structure and a detection device according to the invention
10 arranged thereon, as well as a method for operating a vehicle.

From the prior art, in particular for railway vehicles, various types of rail guards are known. Rail guards are used on a railway vehicle to clear obstructions of above a certain height from the track, either from the rails or the track bed. Many rail guards also have an obstruction detection device, which after a collision of the rail guard with an obstruction
15 generates an electrical signal which can be processed by the control electronics of the railway vehicle and which, for example, triggers emergency braking.

A simple rail guard, based on the snow-plough principle, is for example known from EP 1 930 227 A1. A comparable rail guard is also known from EP 2 017 153 A2. These rail guards serve only to clear obstructions and to prevent damage to the vehicle.

20 In KR 10-0837174 B1, from which the present invention starts, a rail guard is disclosed which not only clears but also detects obstructions, that is to say that in the case of a collision it generates a signal (here an electrical signal) that can be further processed. The obstruction detection operates in such a way that the collision element in the form of a collision bar, upon impact with an obstruction, is moved counter to the direction of travel and
25 thereby comes into contact with sensors arranged behind the collision bar, which generate said electrical signal as a result of the contact made. Here, the collision bar is connected in a fixed manner to two arms, which are spaced apart from one another transversely to the direction of travel or longitudinal direction of the vehicle. At their highest point (furthest away from the top of the rail) the arms have a bend around an axis running transversely to the



longitudinal direction of the vehicle and, behind the bend, are connected with their end to a mount, which is fixedly mounted on a frame structure of the vehicle, namely the bogie frame of the railway vehicle. The bend at the highest point of the respective arm causes a certain elasticity at this point which is intended to allow the collision bar, at the instant of the impact
5 with an obstacle, to resiliently deflect together with the arm to some extent counter to the direction of travel, thereby touching the sensor and then to deflect back to the initial position. In addition, between the mount and the respective arm a further compression spring is also provided which supports the deflection back into the initial position.

The problem with the prior art, however, is that in the area of the bend of the respective arm,
10 that is to say at its highest point, there is a risk of plastic deformation and/or fatigue of the material as a result of previous collisions, which prevents the respective arm from deflecting back into the exact initial position after the collision or from providing the originally defined resistance to a collision. This means that frequent, complex inspections are necessary and possibly the exchange of the arms connecting the collision bar to the vehicle. If this is not
15 carried out then an incorrect detection may result, for example if the collision bar is moved into the area of the sensors by just a small non-hazardous obstacle or simply by the traveling airflow, which in turn can trigger an unnecessary or undesired emergency braking of the railway vehicle. A regular, complex inspection of the arms is therefore unavoidable for safety reasons. Here, exchanging the arms involves considerable assembly effort, since
20 these have a fixed connection with the mount or are designed as an integral part of the latter.

The object of the present invention is therefore to provide a detection device, a vehicle and a method for operating a vehicle, respectively, of the type mentioned in the preamble which does not have the abovementioned disadvantages, or at least has these only to a lesser
25 extent, and in particular which increases the maintenance-friendliness of the components for collision detection.

The present invention solves this problem, in particular, starting from a detection device according to the preamble of claim 1 through the features indicated in the characterising part of claim 1.

30 The present invention is based on the technical teaching that the maintenance-friendliness of the components for collision detection can be increased in a simple manner if the collision

unit is held in a predetermined position by fixing means which only respond when a predetermined intensity of the collision, in particular therefore a predetermined collision force on the collision element, is exceeded, and release a guided deflection of the collision unit relative to the mount. In this way it is possible in a simple manner to take up minor impacts (in collisions with correspondingly small or light obstructions) without undergoing (significant) deflection of the collision unit and to possibly also simply clear such small or light obstructions from the path, while more serious impacts cause a deflection of the collision unit, which is detected and followed by defined reactions in the vehicle (for example, signalling to the vehicle driver and/or an automatic operation of the brakes, etc.).

- 10 Release of deflection of the collision unit only above a certain collision intensity also has the advantage that, at a later point, for example using the state of the fixing means and/or the position of the collision unit, it can easily be detected that a collision of a certain magnitude has taken place, requiring corresponding attention.

According to a first aspect the present invention therefore relates to a detection device for detecting a collision of a vehicle, in particular a railway vehicle, with a collision partner. The detection device comprises a mount for connecting the detection device to the vehicle, at least one collision unit and at least one sensor device. The collision unit comprises at least one collision element for making contact with the collision partner and is mechanically connected to the mount. The at least one sensor is designed to generate a collision signal as a result of a relative movement between the collision unit and the mount. The collision unit is connected to the mount by means of a guide device, wherein the collision unit is secured by at least one fixing means in an initial position relative to the mount. The fixing means is designed to release, in the event of a collision in which a predetermined collision force on the collision element is exceeded, the collision unit in such a way that the collision unit, in a manner guided by the guide device, can deflect from the initial position.

The sensor can basically be of arbitrary design. The sensor is preferably designed to generate, as a function of a direction of deflection of the collision unit from the initial position, a first collision signal or a second collision signal that differs from the first collision signal. In particular in combination with a suitable arrangement and/or guidance of the collision unit it is in this way possible to differentiate between different types of collisions causing deflections of the collision unit in different directions, and to trigger different responses accordingly.

Thus, for example, a collision with an element of a route being travelled, for example a collision with a rail of a track being travelled, as occurs if the vehicle derails, can be detected by means of a first collision signal, which is specific to the first deflection or the first deflection direction, respectively, occurring in this case. Similarly, a collision with an obstruction on the route of the vehicle can be detected by means of a second collision signal, which is specific to the second deflection or second deflection direction, respectively, occurring in this case. If the first and second deflection directions are different, then a distinction can easily be made between the different kinds of collision and different responses can be brought about.

Furthermore, the sensor can work according to any suitable operating principle. Thus, for example, contact sensors can be used. In variants of the invention which are particularly advantageous due to their reduced susceptibility to wear, the sensor operates according to a contactless operating principle.

The mount and the collision unit can basically be connected together in any suitable manner. Preferably, the collision unit and the mount engage with one another in the area of an overlap, wherein, in the area of the overlap, they are connected together by fixing means. This allows particularly robust configurations to be achieved.

A detection device as described above preferably serves for being secured to a railway vehicle, in particular a bogie frame of the railway vehicle. Basically, however, it is also conceivable for such a detection device to be used not only with rail bound vehicles but also with non-rail bound vehicles.

In variants of the detection device according to the invention that are preferred because of their particularly simple design, the collision unit comprises at least one arm, which connects the collision element via the guide device to the mount, wherein the arm is held by the fixing means in the initial position relative to the mount.

The guide device can basically have any suitable design. Thus, for example, it may be designed as a linear guide. Preferably the guide device is designed as a kind of articulated joint, since in this way configurations that are particularly simple to manufacture can be achieved, in which, additionally, in a simple manner the deflection in different deflection directions as described above can be achieved.

The arm can also be designed in any suitable manner. The arm preferably comprises a profile element, in particular a hollow profile element, since in this way the rigidity necessary for the respective application can again be achieved in a particularly simple manner.

5 Preferably the detection device has two arms that are spaced apart from one another transversely to the longitudinal direction, which together hold the collision element, for example a collision bar. Both arms are then mechanically connected to the mount. As connecting elements for connecting the detection device to the vehicle, the mount can in particular have flange plates or similar, which are connected to the vehicle for example by means of a screwed joint and which are connected in any suitable manner (for example
10 welded) to a structure, namely the arm support structure explained in greater detail further below, the serves to support the arms. Here, said arm support structure in the sense of the invention is understood to be part of the mount.

The arm support structure can likewise have any suitable design. The arm support structure preferably comprises a profile element, in particular a hollow profile element, as a result of
15 which, in this area as well, a particularly simple, robustly designed configuration can be achieved. The arm is preferably pivotably supported in the profile element of the arm support structure.

In variants in which the mount has an arm support structure assigned to the arm, with which the arm is pivotably supported via the articulated joint, the arm support structure is
20 preferably designed in such a way that it limits the deflection movement of the arm from the initial position, in particular in two opposing pivot directions. In this way it is possible in a simple manner to achieve different or graduated responses to collisions of differing intensity, in particular to offer varying levels of resistance to collision partners in the course of the collision. In this way it is also possible, at different points in the course of the collision, for
25 example at different deflections of the collision unit, to initiate different responses from the vehicle.

Because the collision unit (for example the respective arm) is connected in a guided manner (for example articulated) to the mount (possibly said arm support structure of the mount) and the collision unit, via a corresponding section (for example the arm) through fixing means is
30 held in its initial position, these fixing means, in the event of a collision that exceeds a predetermined force or intensity, releasing a corresponding section of the collision unit (for

example the arm), it can be guaranteed that a correspondingly strong collision cannot go unnoticed, while the collision unit remains in its initial position for more minor collisions. This preferably applies at least for collisions with relatively low collision forces or impact forces, for example a collision with obstructions having a weight of up to 5 kg and an impact speed
5 of up to 30 km/h. In such cases the obstacle can, for example, be removed from the route in the conventional manner by the collision unit held in its initial position. In the case of higher collision or impact forces, the fixing means for releasing the collision unit experiences a defined deformation, for example is sheared off, as a result of which the arm, in particular in the area of connection to the mount (and thus for example in the area of the articulated joint)
10 at least initially does not sustain any significant damage. Here as well, the obstacle can, for example, be removed from the route by the collision unit deflected from its initial position.

The fixing means, which by way of example can be a bolt-like element, in particular a shear pin, following a collision can be replaced much more easily than a complete arm or the mount and arm assembly.

15 It is similarly possible to design the fixing means as a catch means, which is triggered when a predetermined operating force is exceeded. Thus, the fixing means can, for example, be designed as an element that is pre-stressed by a spring or similar, which for the purposes of fixing engages in an associated recess and, under a predetermined operating force (for example via inclined contact surfaces), is released from engagement with the recess, so
20 that the collision unit is released.

Where within the meaning of the present invention mention is made of the deformability of the fixing means, this does not just mean irreversible deformation, but that the fixing means can possibly also be reversibly deformable, thus, in the case of a collision, can temporarily yield in order to release the arm, but then deform back again into the original state (elastic
25 deformation). The fixing means preferably consists of metal, however, since in this way it can withstand higher forces.

According to an embodiment of the detection device according to the invention, the mount has an arm support structure for each arm, with which the arm is pivotably connected via the articulated joint. This arm support structure is configured to limit the deflection movement of
30 the arm from the initial position, after the latter has been released by the fixing means in the event of a collision. In this way the arm is deflected in a controlled manner in the event of a

collision with a relatively low impact force. The controlled deflection is in turn detected by the sensor and passed on as an electrical signal, for example, to a control device of the railway vehicle, which then in turn preferably initiates a response by the vehicle (for example braking).

- 5 The arm support structure is, in particular, configured so that it can limit the deflection movement of the arm from the initial position in two opposing pivot directions. Thus, with the detection device according to the invention it is not only possible to detect a collision in the longitudinal direction, as a result of which the arm would be deflected from its initial position in the longitudinal direction. Rather, the detection device can be used for detecting a
- 10 derailment of a railway vehicle, in which then the collision element, once the wheels of the railway vehicle have left the track, comes into contact with the top of the rail and is deflected in the pivot direction opposite to the pivot direction experienced in case of a collision with an obstacle on the rails. In the latter case as well, the arm support structure guarantees that the arm is deflected in a controlled and not in a completely arbitrary manner, as a result of
- 15 which a correspondingly accurate and reliable detection of the deflection by the sensor can take place. Also in the case of a deflection of the arm caused by a derailment the sensor can send a corresponding signal to a control device of the railway vehicle, as a result of which a suitable response of the vehicle (for example emergency braking) can be triggered.

Said arm support structure preferably is a profile element, in particular a hollow profile

20 element. A hollow profile element can, for example, have a tubular round or square or also U-shaped cross section. Basically, by way of example, a profile element with an L-shaped cross section is also conceivable. In particular, the arm is then pivotably supported within the profile element, i.e. in the interior of the latter. The limitation of the pivot movement in this case takes place by the arm abutting against the profile element surrounding it.

- 25 The arm itself can also be a profile element, in particular a hollow profile element, which likewise can have the abovementioned types of cross section. If the arm is a profile element, then it is also basically conceivable that the arm is pivotably supported outside of the arm support structure (on the latter), thus at least to some extent surrounding the arm support structure. The limitation of the pivot movement would then take place by the arm
- 30 abutting against the profile element positioned in its interior and forming the arm support structure.

The use of profile elements for the arm and/or arm support structure has the advantage that these have a relatively high rigidity and at the same time relatively low weight. Basically, however, it is also conceivable that the arm, if this is supported in a profile element forming the arm support structure can also consist of solid material rather than a profile element.

- 5 Conversely, it is also conceivable that the arm support structure, if this is located at least section-wise in the interior of an arm in the form of a profile element, can likewise consist of solid material.

According to a further configuration of the detection device according to the invention the collision unit (for example the arm) has a first energy absorption section (for example a first
10 predetermined buckling location), and/or the mount (for example the arm support structure) has a second energy absorption section (for example a second predetermined buckling location). In this way, through energy absorption in the area of the energy absorption section concerned, it is possible in an advantageous manner to reduce the loads being introduced into the vehicle in the event of a collision.

- 15 A predetermined buckling location within the meaning of the present invention is a defined deformation zone. Preferably, the predetermined buckling location is provided in the form of a weakened cross-section, particularly preferably in the form of a material recess. A weakened cross-section means a local weakening of the material, in particular of the profile element, forming the collision unit (for example the arm) or the mount (for example the arm
20 support structure). This can be brought about, for example, by a local modification of the material structure or a local reduction in cross section. Particularly when the arm support structure and/or the arm is formed by a profile element, a material recess has proven to be particularly suitable for forming the defined deformation zone. Such a defined deformation zone or predetermined buckling location, respectively, has the advantage that, in a collision
25 resulting in a relatively high impact force, the frame structure of the vehicle, in particular the bogie frame of a railway vehicle, is not damaged. Through the defined deformation of the energy absorption section (hence, for example, of the arm and/or the arm support structure), impact energy is not or only to a small extent passed on into the vehicle structure. This serves to protect the vehicle from damage. With a railway vehicle this can also prevent that,
30 following a heavy collision, components of the detection device get caught under the wheels of the railway vehicle and cause derailment.

The first and second energy absorption sections (thus, for example, the predetermined buckling location of the arm and the predetermined buckling location of the arm support structure) are preferably arranged in alignment to one another, that is to say that the first and second energy absorption sections (thus, for example, the predetermined buckling locations) are positioned at approximately the same level in relation to the direction of extension or longitudinal center axis of the arm and arm support structure. The first and second energy absorption sections (thus, for example, the predetermined buckling locations of the arm and arm support structure), in particular, run aligned with each other transversely to the longitudinal direction of the vehicle. Thus, the detection device, in the event of a heavy collision, ideally only buckles at one location, that is to say, preferably, in an area in which the collision unit and the mount (thus, for example, the arm and the arm support structure) overlap (hence, for example, where the arm is guided in the arm support structure).

The energy absorption section concerned (thus, for example, the predetermined buckling location) is preferably configured such that, when a defined second collision force greater than the first defined collision force, at which the fixing means responds (thus for example deforms or shears), is exceeded, this leads to a deflection (for example a folding) of the section of the detection device located on the collision side of the energy absorption section (thus, for example, vertically below the predetermined buckling location). In this case also, however, the collision unit is first released by the fixing means as a result of which the collision unit can be deflected and the sensor can indicate a collision.

According to a further configuration of the detection device according to the invention, the guide device (thus, for example, the articulated joint) defines a pivot axis, which substantially extends parallel to the plane of the wheel contact point (hence, on a straight, level track, extends substantially horizontally). The pivot axis, about which the collision unit (and with it therefore, for example, the arm) can pivot, extends transversely, in particular perpendicularly to the longitudinal direction of the vehicle.

As has already been mentioned, according to a further embodiment of the rail guard according to the invention, the fixing means is a bolt-like element, in particular a shear pin, for example a metal pin. An elastic element, for example made of rubber, is also conceivable as the fixing means. Preferably, the fixing means is inserted through a receptacle, in particular a hole, both in the arm and in the mount, in particular of the arm

support structure. Following collisions that have in fact caused the fixing means to respond but no response from an energy absorption section (thus, for example, folding at a predetermined buckling location), all that is required is to fit a new bolt.

According to a further embodiment of the rail guard according to the invention, the fixing means is configured in such a way that it can deform, in particular can be sheared off, parallel to the longitudinal direction of the vehicle, i.e. in the direction of impact. If the fixing means is a bolt-like element, then the center axis of the bolt preferably runs transversely to the longitudinal direction of the vehicle.

According to yet another embodiment of the detection device according to the invention, the sensor is a distance sensor, which is preferably configured in such a way that it can detect both an increase in distance and a decrease in distance between a section of the collision unit (for example the arm) and the sensor. In this way, the sensor can both detect a collision with an obstruction on the route and a derailment and generate a corresponding collision signal (which in the case of derailment, for example, triggers an emergency braking of the vehicle). The sensor can preferably also detect a change in the distance between the arm and the arm support structure, wherein the sensor in this case, in particular, is secured to the arm support structure.

According to a further configuration of the rail guard according to the invention, a height adjustment device is provided between the collision element and the mount. In this way, a defined distance between the collision element and the track (for example the top of rail) can be adjusted in the height direction of the vehicle. With wheel wear, in particular of a railway vehicle, the wheel diameter necessarily changes so that, over time, the distance between the collision element and the track (for example the top of rail) reduces. Using the height adjustment device, this distance can be readjusted. The height adjustment device is preferably formed by a pair of toothed plates, which, in particular, is arranged between an arm and the collision element of the collision unit.

The present invention also relates to a vehicle, in particular a railway vehicle, with a vehicle structure, wherein on the vehicle structure a detection device according to the invention is arranged. In this way, the advantages and variants described above in connection with the detection device according to the invention can be achieved to the same extent, so that, in this context, reference is made to the explanations given above.

With the vehicle according to the invention it is preferably envisaged that the collision unit, for generating different collision signals of the detection device for a first collision with an element of a route being travelled, in particular a rail of the route, and a second collision with an obstruction on the route, is arranged in such a way that the collision unit, at the time of the first collision and the second collision, starting from an initial position, experiences a deflection in different deflection directions. This allows a distinction to be made in an advantageous manner between collisions with different collision partners.

Additionally or alternatively, with the vehicle according to the invention, it is preferably provided that the detection device is connected to a control device of the railway vehicle, which, as a function of different collision signals from the detection device, triggers different responses from the vehicle, in particular different braking processes. In this way, a distinction can be made in an advantageous manner between collisions based on the nature and/or seriousness of the latter, and, for example as a function of a hazard classification a currently detected collision is assigned to, suitably tailored responses can be triggered.

In particular in connection with the detection and differentiation of collisions with different collision partners described above (for example the collision with a rail, as happens during a derailment, and the collision with an obstruction in the track area), as a result, different responses that are tailored to the collision situation can be triggered.

The vehicle according to the invention, where it is designed as a railway vehicle, preferably has an arm support structure and a bogie frame with a detection device according to the invention mounted on the bogie frame. Here, the collision element (for example a collision bar) is preferably at least section-wise arranged in the longitudinal direction of the vehicle (impact direction) in front of the wheels and vertically above the running track (in the case of non-rail vehicles) or vertically above the rails (in the case of rail vehicles), respectively. The distance between the collision element and the plane of the wheel contact point (for example therefore also the top of rail), is preferably between 50 mm and 150 mm, preferably between 70 mm and 130 mm, particularly preferably between 80 mm and 120 mm.

In preferred variants of the vehicle according to the invention, the detection device has at least one energy absorption section, in particular at least one predetermined buckling location. The at least one energy absorption section defines a center of a pivot movement of the collision unit, which occurs in the case of a collision caused plastic deformation of the

at least one energy absorption section. A distance (a) between the center and a closest wheel of the vehicle is greater than a distance (b) between the center and a point of the collision element located, in a plane of the pivot movement, furthest away from the center. As a result, in a simple and reliable manner the collision element, in the event of a response
5 of the energy absorption section and the resulting deflection of the collision unit, can be prevented from reaching the area of the adjacent wheels, as a result of which otherwise there would be a high risk of derailment.

According to an embodiment of the vehicle according to the invention, an arm and/or an arm support structure of the detection device therefore has a predetermined buckling location.

10 Here, the distance between the center of the respective predetermined buckling location and the nearest wheel is greater than the distance between the center of the predetermined buckling location and the most remote point of the collision element (in the plane of the movement that takes place when the predetermined buckling location responds). In the event of a collision leading to a deformation in the area of the predetermined buckling
15 location, this reliably prevents parts of the detection device getting caught between the wheels and the track (for example the rails), which, on a railway vehicle, could lead to a derailment.

The present invention further relates to a method for operating a vehicle, in particular a railway vehicle, in which, by means of a detection device according to the invention, in the
20 event of a collision of the collision unit with a collision partner, during which a predetermined collision force on the collision element is exceeded, through a deflection of the collision unit from the initial position, a collision signal is generated, the collision signal is processed in a control device of the vehicle and the control device triggers a collision response by the vehicle. Here also, the advantages and variants described in connection with the detection
25 device according to the invention or the vehicle according to the invention can be achieved to the same extent, so that in this context reference is made to the explanations given above.

Here, it is self-evident that, basically, any suitable collision responses can be triggered. The collision response by the vehicle preferably comprises the issue of a collision message. The
30 collision message can, for example, be output (optically and/or acoustically) to the vehicle driver, who can then take appropriate measures. Additionally or alternatively, the collision response can comprise the output of control signals for any components of the vehicle.

These can be any components of the vehicle that initiate measures as a function of these control signals, in order to reduce as far as possible any danger to the vehicle and/or the passengers resulting from the collision. Thus, individual ones or arbitrary combinations of braking devices, drive devices, energy absorption devices of the vehicle (in particular
5 between individual cars of the vehicle), door devices, passenger information systems, and so on, can be controlled. Additionally or alternatively to the collision message, preferably, at least one braking signal is generated, in order to slow the vehicle and thus reduce the danger to the vehicle and/or passengers.

In preferred variants of the method according to the invention, with which, for example,
10 detection of derailment can take place, a first collision signal is generated as a function of a first deflection of the collision unit from the initial position in a first deflection direction, which takes place in the course of a first collision of the collision unit with an element of a track being travelled (in particular a rail of a track being travelled). In the presence of a first collision signal, the control device then triggers a first collision response, in particular an
15 emergency braking signal.

Additionally or alternatively, a second collision signal is generated as a function of a second deflection of the collision unit from the initial position in a second deflection direction, which takes place in the course of a second collision of the collision unit with an obstacle on a track being travelled. In the presence of the second collision signal, the control device then
20 triggers a second collision response, in particular again a braking signal.

It is self-evident that, upon detection of a derailment, the most powerful braking possible (typically so-called emergency braking) can be automatically triggered, while upon detection of a collision with an obstacle a weaker response or braking, respectively, can take place. The strength of the response to the collision with an obstacle is preferably dependent upon
25 the intensity of the collision. In preferred variants of the method according to the invention, therefore, it is provided that the collision unit, in the course of the second collision, when a predetermined first collision force on the collision element is exceeded, is deflected from the initial position in the second deflection direction, wherein a braking signal in particular is triggered. In addition, in the course of the second collision, when a predetermined second
30 collision force on the collision element is exceeded, which exceeds the first collision force, a third deflection of the collision unit takes place, in particular under a plastic deformation of at least one energy absorption section of the detection device. At the same time, a third

collision signal is generated, wherein the control device, in the presence of the third collision signal, then triggers a third collision response, in particular an emergency braking signal.

Further preferred embodiments of the invention become apparent from the claims and the following description of preferred embodiments which refers to the attached drawings. The
5 drawings show in:

Figure 1a) to d) various views of a preferred embodiment of a detection device according to the invention, which is used in a preferred embodiment of a vehicle according to the invention, which can be operated with a preferred embodiment of the method according to the invention;

10 Figure 2 a sectional view of the detection device from Figure 1;

Figure 3a and b) schematic representations of possible deflection movements of an arm of a detection device according to the invention;

Figure 4a and b) schematic representations of various adjustment possibilities of a detection device according to the invention;

15 Figure 5 a schematic side view of part of a railway vehicle according to the invention with a mounted detection device;

Figure 6 a schematic sectional view of a further preferred embodiment of the detection device according to the invention.

20 Figure 1a) is a perspective view of a preferred embodiment of a detection device according to the invention in the form of a rail guard 1. The rail guard 1 serves for mounting on a railway vehicle in the manner shown, as an example, in Figure 5. In the mounted state, the rail guard 1 allows detection and removal of obstacles on the track, in particular the rails of a track (shown in Figure 1 by the wheel contact plane or the plane 13 defined by the top of rail), and the detection of a derailment.

25 Figure 1b) is a front view of the rail guard 1 from figure 1a).

Figure 1c) is a sectional view of the rail guard 1 along the sectional line A-A in Figure 1b).

Figure 1d) is a top view of the rail guard 1 according to Figure 1a).

The rail guard 1 is provided with a mount 2 which, as shown in Figure 1b) and d), has two flange plates as connecting elements 3 for joining the rail guard 1 to the vehicle and two arm support structures 9 joined to the flange plates 3 (e.g. by welding, riveting, screwing or adhesive bonding, etc.). The mount 2 is thus a one-piece component, which is screwed to the vehicle via screws 3.1. It can also be designed as a multi-part component, however.

The rail guard 1 also has a collision element in the form of a collision bar 4 made from a hollow profile, which extends between the left and right parts of the mount, i.e. between the two arm support structures 9 (Figure 1b) and d)). Here, the collision bar 4 extends transversely to a longitudinal direction L, which defines the direction of impact of a possible obstacle and extends parallel to a longitudinal direction of the vehicle and a direction of travel of the vehicle, respectively. As shown in Figure 1b), the collision bar 4 (on a straight, level track) is arranged horizontally and parallel to the plane 13, which is defined by the top of rail. Here, it is self-evident that, in other variants of the invention, the collision bar can also extend beyond the two arm support structures.

In addition, two arms 5 are provided, which are spaced apart from one another transversely to the longitudinal direction L and which join the collision bar 4 mechanically to the mount 2, more precisely, to the two arm support structures 9 of the mount 2. The arms 5 and the collision bar 4 together form a collision unit of the rail guard 1.

Finally, for each arm 5, a sensor 6 is connected to the mount 2, more precisely, in each case, to an arm support structure 9, the sensor 6 serving to detect a relative movement between the collision bar 4 (or the arm 5, respectively) and the mount 2 (or the arm support structure 9, respectively). The sensor 6 can be a distance sensor or a movement sensor. In the present example, the sensor 6 works according to a contactless operating principle. It is self-evident, however, that, in other variants of the invention, a contact sensor can also be used.

As shown, in particular, in the sectional view of Figure 2 along the sectional line B-B of Figure 1b), each arm 5 is pivotably connected to the mount 2, in particular the arm support structure 9, by means of a guide device in the form of an articulated joint 7. The respective arm 5 is also retained by a bolt-like fixing means 8 in the form of a metal shear pin in its

initial position relative to the mount 2 as shown in Figure 2. Possible deflections from this initial position are shown in Figure 3 and are described in greater detail in the following.

The bolt-like fixing means 8 is deformable under the effect of a defined first force, which results from a first collision force or impact force introduced into the collision bar 4, in this specific present case it can be destroyed by shearing, which results in the release of the arm 5 and deflection from the initial position.

In the embodiment described here, the fixing means is located in a horizontal plane (on a straight, level track), which is positioned vertically below a horizontal plane, in which the articulated joint 7 or the axis of articulation of the articulated joint 7, respectively, extends.

According to the invention, however, it is also conceivable that the fixing means 8 lies in a horizontal plane positioned vertically above the horizontal plane, in which the articulated joint 7 or the axis of articulation, respectively, extends.

The arm support structure 9, to which the arm 5 is pivotably connected by means of the articulated joint 7, is configured in such a way that it limits the deflection movement of the arm 5, as shown in Figures 3a) and b), in two opposing deflection directions, that is to say two opposing pivot directions. So, Figure 3a) is a schematic representation of the case where a collision takes place with an impact force F acting on the collision bar 4 in the longitudinal direction L . If the impact force F exceeds the value of a first collision force, the fixing means 8 responds in that it is deformed or sheared off, resulting in the arm 5 being released and deflected in the longitudinal direction L . The arm support structure 9, which like the arm 5 consists of a hollow profile, is sufficiently rigid that the deflection movement is limited by the arm support structure 9 in the longitudinal direction L , provided that a certain level of force is not exceeded, as described in more detail below.

Figure 3b) illustrates a case in which the deflection movement of the arm 5 takes place in the opposite direction, that is to say counter to the longitudinal direction L , and is possibly limited. This case arises if the railway vehicle derails and, as a result, the collision bar 4 collides with an element of the route, that is to say the top of rail, indicated in Figure 1c) by contour 13, as a result of which an impact force F in the vertical direction, orthogonally to the longitudinal direction L results, which likewise exceeds the first collision force, causing the fixing means 8 to respond and release the arm 5, such that the arm 5 with the collision bar 4 is pressed against the front end of the arm support structure 9. Here, the arm support

structure 9 can be designed in such a way and the distance between the articulated joint 7 and the rail 13 selected such that the arm support structure 9 stands firm.

A sensor 6 in the form of a distance sensor (see Figure 2, Figure 3a) and b)) detects the deflection of the arm 5 in relation to the initial position and even preferably detects whether there is a reduction in distance (the sensor 6 sends a first collision signal) or an increase in distance (the sensor 6 sends a second collision signal).

In the event of a reduction in distance (first collision signal), a control device connected by cable and/or wirelessly to the sensor can conclude that there been a derailment has occurred, and, in the event of an increase in distance (second collision signal), that an impact with an obstacle on the track has occurred. The control device can thereupon, for example, trigger a response, such as, for example, an (optical or acoustic) issuance of a collision message and a braking signal to initiate a braking of the vehicle, for example emergency braking in the case of derailment of the railway vehicle.

For the case that the impact force F exceeds a predetermined second collision force, leading to damage at least of the arm 5 and/or the arm support structure 9, a first energy absorption section in the form of a predetermined buckling location 5.1 on the arm 5 and a second energy absorption section in the form of a predetermined buckling location 9.1 on the arm support structure 9 is provided respectively. As shown, in particular in Figure 1c), the two predetermined buckling locations 5.1 and 9.1, both of which are formed as a material recess, are aligned in succession transversely to the longitudinal direction L , so that the rail guard 1, when the second collision force is exceeded, is plastically deformed in the area of the two predetermined buckling locations 5.1 and 9.1 and, accordingly, yields in a defined manner. Thus the first energy absorption section 5.1 and the second energy absorption section 9.1 respond when the second collision force is exceeded, as a result of which at least part of the collision energy is absorbed and, accordingly, the loads introduced into the vehicle structure are reduced.

Figures 4a) and b) show various adjustment possibilities of a height adjustment device 10 provided between the collision bar 4 and the arm 5 or the mount 2, respectively. The height adjustment device 10 is, as shown in particular in Figure 2, a pair of toothed plates 10.1, 10.2, wherein the toothed plate 10.1 is mounted on the arm 5 and the toothed plated 10.2 is mounted on the collision bar 4. By adjusting the toothed plates 10.1 and 10.2 relative to one

another in the vertical direction, the distance x between collision bar 4 and track level or the top of rail 13, respectively, can be set. The distance x corresponds also to the distance between the horizontal plane, in which the underside of the collision bar 4 lies, and the horizontal plane, in which the underside of the running surface of the wheels 12 of the vehicle lies (Figure 5). The desired value of x is typically 100 mm, measured from the top of rail (plane 13).

In this way, wear of the wheels 12, as a result of which the vertical level of the frame structure 11 and, thus, of the rail guard 1 decreases, can be compensated.

Finally, Figure 5 shows part of a vehicle structure 11, here in the form of a bogie frame of a railway vehicle, and a rail guard 1 mounted thereon. The collision bar 4, at least section-wise, is positioned, in the longitudinal direction L , in front of the wheels 12 and vertically above the top of rail 13 upon which the running surface of the wheels 12 rests.

From Figure 5 it is apparent that it is preferable according to the invention, if the distance a between the center 5.11 and 9.11 of the respective predetermined buckling location 5.1 and 9.1, which in each case represents (at least approximately) a center of a deflection movement of the collision bar 4 when the predetermined buckling locations 5.1 and 9.1 respond, and the nearest wheel 12 is greater than the distance b between the center 5.11 and 9.11 of the predetermined buckling location 5.1 and 9.1 and the most remote point 4.1 of the collision bar in the plane of the deflection movement. In this way, in the event of a heavy collision between an obstacle and the collision bar 4 in the longitudinal direction and the resulting response of the predetermined buckling locations 5.1 and 9.1, no component of the rail guard 1 may get caught under the wheels 2 and thereby cause a derailment.

With certain variants of the present invention it can be envisaged that the sensor 6 is connected to part of the mount 2 located on the vehicle side of the predetermined buckling locations 5.1 and 9.1, such that, when the predetermined buckling locations 5.1 and 9.1 respond, it is not deflected with them. In this way it is possible, via the sensor 6 to detect the response by the predetermined buckling locations 5.1 and 9.1 as a result of the further increase in distance occurring here (beyond the threshold value resulting from the resting of the arm 5 on the arm support structure 9) and to send a third collision signal. This third collision signal can, for example, be used by the control device to trigger further responses.

Thus, for example, it can be provided that, as a result of the second collision signal generated following the response of the fixing means 8, only a normal application of the brake (if necessary with the highest possible braking power of the service brake but with a deceleration that is generally still manageable for passengers without problems) can be triggered, whereas, with the third collision signal generated after a response by the predetermined buckling locations 5.1 and 9.1, (similar to a derailment) an emergency braking (if necessary with maximum braking power of the available braking systems and thus the maximum possible deceleration) is triggered, in order to bring the vehicle to a standstill in the quickest manner.

- 10 It is pointed out here that, additionally or alternatively, further collision signals can be provided for, which are generated by the sensor 6 for certain deflections of the arm 5 and which in each case are assigned corresponding responses from the control device.

It is also pointed out here that the rail guard 1, even after the response from the fixing means 8, possibly also after the response by the predetermined buckling locations 5.1 or 9.1, retains its ability to clear the obstacle hit from the track, if necessary to the side, or to prevent the obstacle from getting caught between the wheels 12 and the rails. It may also lose this function (if at all) only if the predetermined buckling locations 5.1 or 9.1 experience further deformation. In any case, the rail guard 1 has this clearance function in the event of a collision with smaller obstacles, when there is not yet a response from the fixing means 8.

- 20 In the following, with reference to Figure 6, a further preferred embodiment of the detection device 1 according to the invention is described. The detection device 1 from Figure 6, in its basic design and functionality, corresponds to the detection device 1 from Figure 1 to 5, so that, here, only the differences will be dealt with.

25 There is one difference in the design of the guide device 7, which performs the deflection of the collision element 4 following the response by the fixing means 8. In the present example, the guide device 7 is designed as a linear guide in the form of a recess (for example a cylindrical hole) in the mount 2, in which a guide bolt 5 (for example a cylindrical bolt) securely (in particular substantially rigidly) connected to the collision element 4 is received in a sliding manner.

A further difference is the design of the fixing means 8, which, in the present example, is designed as elastic catch means 8. The catch means have projections arranged on an elastic arm, which engage an associated recess on the collision element 4. The contact surfaces between the projections of the catch means 8 and the collision element, which are inclined to the direction of the collision force F , and the stiffness of the elastic arms of the catch means 8 are matched in such a way that the catch means, again, when the first collision force is exceeded, respond by being pushed fully out of the recesses in the collision element 4 through a corresponding forward motion of the collision element 4, as a result of which the positive fit between the catch means 8 and the collision element 4 is released and the latter (except for the frictional force acting between the catch means 8 and the collision element 4) can move substantially freely until it abuts against the mount 2.

If the collision force F exceeds a second collision force, then, here again, a plastic deformation of the mount 2 occurs in the area of an energy absorption section in the form of a predetermined buckling location 9.1 of the mount 2.

In the present example, the deflection (here the displacement) of the collision element 4 is also again detected via the sensor 6 and transmitted to the control device of the vehicle in the form of corresponding collision signals.

The present invention, in the foregoing, has been described using examples for railway vehicles exclusively. It is once again mentioned here that it can nevertheless also be used in connection with any other vehicles.

* * * * *

Claims

1. Detection device (1) for detecting a collision of a vehicle, in particular a railway vehicle, with a collision partner, comprising
 - a mount (2) for connecting the detection device (1) to the vehicle,
 - 5 – at least one collision unit (4, 5) and
 - at least one sensor device (6), wherein
 - the collision unit (4, 5) comprises at least one collision element (4) for making contact with the collision partner,
 - the collision unit (4, 5) is mechanically connected to the mount (2), and
 - 10 – the at least one sensor (6) is designed to generate a collision signal in response to a relative movement between the collision unit (4, 5) and the mount (2),characterised in that
 - the collision unit (4, 5) is connected to the mount (2) by means of a guide device (7), wherein
 - 15 – the collision unit (4, 5), by at least one fixing means (8), is secured in an initial position relative to the mount (2) and wherein
 - the fixing means (8) is designed in such a way to release, in the event of a collision in which a predetermined collision force on the collision element (4) is exceeded, the collision unit (4, 5) in such a manner that the collision unit (4, 5)
 - 20 – guided by the guide device (7) can deflect from the initial position.
2. Detection device (1) according to claim 1, characterised in that
 - the sensor (6) is designed to generate, as a function of a deflection direction of the collision unit (4, 5) from the initial position, a first collision signal or a second collision signal different from the first collision signal
 - 25 and/or
 - the sensor (6) operates according to a contactless operating principle.

3. Detection device (1) according to claim 1 or 2, characterised in that the collision unit (4, 5) and the mount (2) engage with one another in the area of an overlap and they are connected together by the fixing means (8) in the area of the overlap.

5 4. Detection device (1) according to any one of the preceding claims, characterised in that

- the collision unit (4, 5) comprises at least one arm (5), wherein
- the arm (5) connects the collision element (4) via the guide device (7) to the mount (2) and
- the arm (5) is held by the fixing means (8) in the initial position relative to the mount (2), wherein
- the guide device (7), in particular, is designed in the manner of an articulated joint (7),

10 and/or

- the arm (5), in particular, comprises a profile element, in particular a hollow profile element.

15 5. Detection device (1) according to claim 4, characterised in that

- the mount (2) has an arm support structure (9) assigned to the arm (5), to which the arm (5) is pivotably connected via the articulated joint (7), wherein
- the arm support structure (9) is designed in such a manner that it limits the deflection movement of the arm (5) from the initial position, in particular, in two opposing pivot directions,

20 and/or

- the arm support structure (9) comprises a profile element, in particular a hollow profile element, wherein, in particular, the arm (5) is pivotably supported in the profile element.

6. Detection device (1) according to any one of the preceding claims, characterised in that,

– in order to reduce the loads introduced into the vehicle in the event of a collision, the collision unit (4, 5) has a first energy absorption section (5.1), in particular a first predetermined buckling location (5.1), and/or the mount (2) has a second energy absorption section (9.1), in particular a second predetermined buckling location (9.1), wherein

– the energy absorption section (5.1, 9.1), in particular, is designed in the form of a cross sectional weakening, preferably in the form of a material recess,

and/or

– the first energy absorption section (5.1) and the second energy absorption section (9.1) are arranged to be, in particular, substantially aligned with one another, preferably transversely to a longitudinal direction (L) of the vehicle.

7. Detection device (1) according to any one of the preceding claims, characterised in that the guide device (7) defines a pivot axis (X), that runs transversely to a longitudinal direction (L) of the vehicle, in particular substantially perpendicularly to the longitudinal direction (L) of the vehicle.

8. Detection device (1) according to any one of the preceding claims, characterised in that

– the at least one fixing means (8) is a bolt-like element, in particular a shear pin, and/or

– the at least one fixing means (8) is configured in such a way that it can be deformed, in particular sheared off, parallel to a longitudinal direction (L) of the vehicle,

and/or

– the at least one fixing means (108) is designed as an elastically supported catch element.

9. Detection device (1) according to any one of the preceding claims, characterised in that the sensor (6) is a distance sensor, which is preferably configured in such a way that it can detect both an increase in distance and a decrease in distance between the collision unit (4, 5) and the sensor (6).
- 5 10. Detection device (1) according to any one of the preceding claims, characterised in that
- a height adjustment device (10) for setting a position of the collision element (4) in relation to the mount (9) in a height direction of the vehicle is provided, wherein the height adjustment device (10), in particular, comprises a pair of toothed plates (10.1, 10.2),
- 10 and/or
- the collision unit (4, 5) is designed to clear a collision partner from the route of the vehicle, in particular in the event of a collision, during which the predetermined collision force on the collision element (4) is not exceeded.
- 15 11. Vehicle, in particular a railway vehicle, with a vehicle structure (11), characterised in that
- on the vehicle structure (11) a detection device (1) according to any one of the preceding claims is arranged, wherein
 - it is provided, in particular, that the collision unit (4, 5) for generating different collision signals of the detection device (1) for a first collision with an element of a route being travelled, in particular a rail of the route, and a second collision with an obstruction on the route, is arranged in such a way that the collision unit (4, 5) at the time of the first collision and the second collision, starting from an initial position, experiences a deflection in different deflection directions,
- 20 and/or
- it is provided, in particular, that the detection device (1) is connected to a control device of the vehicle, which as a function of different collision signals from the detection device (1) triggers different responses of the vehicle, in particular different braking processes.
- 25

12. Vehicle according to claim 11, characterised in that

- the detection device (1) has at least one energy absorption section (5.1, 9.1), in particular at least one predetermined buckling location (5.1, 9.1), wherein
- the at least one energy absorption section (5.1, 9.1) defines a center (5.11, 9.11) of a pivot movement of the collision unit (4, 5), which occurs in the case of collision caused plastic deformation of the at least one energy absorption section (5.1, 9.1), and wherein
- a distance (a) between the center (5.11, 9.11) and a closest wheel (12) of the vehicle is greater than a distance (b) between the center (5.11, 9.11) and a point (4.1) of the collision element (4) most remote from the center (5.11, 9.11) in a plane of the pivot movement.

13. Method for operating a vehicle, in particular a railway vehicle, in which

- by means of a detection device (1) according to any one of claims 1 to 10, in the event of a collision of the collision unit (4, 5) with a collision partner, in which a predetermined collision force on the collision element (4) is exceeded, a collision signal is generated in response to a deflection of the collision unit (4, 5) from the initial position, the collision signal is processed in a control device of the vehicle and the control device triggers a collision response by the vehicle, wherein
- the collision response by the vehicle, in particular, is the issuance of a collision message and/or a braking signal.

14. Method according to claim 13, characterised in that,

- in response to a first deflection of the collision unit (4, 5) from the initial position in a first deflection direction, which takes place in the course of a first collision of the collision unit (4, 5) with an element of a route being travelled, in particular a rail of the track, in particular for derailment detection, a first collision signal is generated and the control device, in the presence of the first collision signal, triggers a first collision response, in particular an emergency braking signal,
- and/or
- in response to a second deflection of the collision unit (4, 5) from the initial position in a second deflection direction, which takes place in the course of a

second collision of the collision unit (4, 5) with an obstacle on a track being travelled, a second collision signal is generated and the control device, in the presence of the second collision signal, triggers a second collision response, in particular a braking signal.

- 5 15. Method according to claim 14, characterised in that
- the collision unit (4, 5), in the course of the second collision, when a predetermined first collision force on the collision element (4) is exceeded, is deflected from the initial position in the second deflection direction and, in particular, a braking signal is triggered, and,
 - 10 – in the course of the second collision, when a predetermined second collision force on the collision element (4), which exceeds the first collision force, is exceeded, in particular under a plastic deformation of at least one energy absorption section (5.1, 9.1) of the detection device (1), a third deflection of the collision unit (4, 5) takes place, a third collision signal is generated and the control device, in the
15 presence of the third collision signal, triggers a third collision response, in particular an emergency braking signal.

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