

DESCRIPTION

Detonation energy absorption device and vehicle
equipped with same

5

The invention relates to an energy absorption device for protecting a vehicle element, in particular a vehicle element of a military vehicle, against a detonation effect, comprising a first fastening element which can be connected to a vehicle chassis or a vehicle hull, and a second fastening element which can be connected to the vehicle element which is to be protected, at least two webs being arranged between the first and the second fastening element.

15

Furthermore, the application relates to a vehicle with an energy absorption device of this type.

DE 10 2010 052 151 A1 has disclosed a cab for a construction vehicle, which cab has at least one hydraulically damped rubber bearing means and, in the rear region of the cab, at least one roll stabilization means. As a result, improved suspension comfort of the cab in the case of relatively rapid transport journeys is achieved. In principle, however, suspension systems of construction vehicle cabs follow quite different objectives (they do not provide any protection against detonations) than suspension systems of military vehicles, with the result that they are not comparable.

30

DE 10 2007 002 576 A1 has disclosed a decoupled pedal unit with a foot plate of a military vehicle.

Suspension systems of vehicle elements of military vehicles are known, for example, from DE 10 2008 053 152 A1 and WO 2014/048420 A1. Said documents in each case disclose deformation means which mount a vehicle element. The deformation means are configured to be deformed in the case of a mine impact and to absorb

35

energy, with the result that the mine impact cannot be transmitted directly to the vehicle element. Both the fastening means and the webs are not provided in a common plane, but are intended to move past one another during the deformation. The deformation means which are disclosed from DE 10 2008 053 152 A1 and WO 2014/048420 A1 in said documents are of comparatively large overall design, and solve the conflict of objectives between elastic mounting and energy absorption in the case of a plastic deformation merely to an insufficient extent.

Proceeding herefrom, the invention is based on the object of providing an energy absorption device for a vehicle, in particular a military vehicle, which energy absorption device has a small overall design and solves said conflict of objectives.

Said object is achieved by way of the energy absorption device of claim 1. Advantageous refinements and developments are the subject matter of the respective subclaims.

According to the invention, an energy absorption device is provided for protecting a vehicle element, in particular of a military vehicle, against a detonation effect. The energy absorption device comprises a first fastening element which can be connected to a vehicle chassis or a vehicle hull, and a second fastening element which can be connected to the vehicle element which is to be protected. At least two webs are arranged between the first and the second fastening element. The at least two webs are arranged in such a way that they lie above one another in a common plane.

Furthermore, according to the invention, a vehicle, in particular a military vehicle, is provided, comprising an energy absorption device of this type or as described in the following text and a vehicle element,

the vehicle element being connected via the energy absorption device to the vehicle.

5 The vehicle can be, for example, a wheeled or tracked vehicle. The tracked vehicle can be, for example, an armoured recovery vehicle, a sapper tank, a mine clearing tank, an armoured personnel carrier or a battle tank. The wheeled vehicle can be, for example, a heavy truck, a semitrailer, a crane or a light wheeled
10 tank.

The energy absorption device according to the invention provides an energy absorption device of small overall design which firstly provides elastic mounting of the
15 vehicle element which can be connected to it and can likewise absorb a high amount of energy in the form of deformation energy in the case of a detonation.

The vehicle element which is connected to the energy
20 absorption device can be, for example, a cab or a protective space of a vehicle. The cab can be, in particular, a protected cab. The vehicle element can likewise be a vehicle body, a platform, a floor, a sprung floor, an intermediate floor, a floor panel or a
25 constituent part of one of the abovementioned elements.

Furthermore, the vehicle element can be a foot plate, a seat means, a weapons system, a device mount, a shelf or can be a constituent part of one of the
30 abovementioned elements.

By way of the energy absorption device according to the invention, the vehicle element is protected against a detonation effect, as can be brought about, for
35 example, by way of a mine or a booby trap.

The energy absorption device according to the invention makes it possible that it is deformed plastically in a

controlled manner in the case of a detonation and the vehicle element which can be connected to it is not damaged.

- 5 It can preferably be provided that the webs have at least one deformation zone.

The at least one deformation zone is a zone, in which the webs deform in a plastic manner if they are
10 deflected to a correspondingly pronounced extent. This takes place by way of the construction of the energy absorption device which causes the webs to deform in the deformation zones first of all.

- 15 Furthermore, it can be provided that the webs are weakened in the deformation zones by way of material selection or geometry in such a way that they deform in the deformation zones first of all.

- 20 Furthermore, it can be provided that the first fastening element, the second fastening element, the at least two webs and the at least one deformation zone are arranged in such a way that they lie above one another in the plane which lies perpendicularly with
25 respect to the first and the second fastening element.

- Here, the fastening elements and the webs of the energy absorption device are arranged in a common plane in a concertina-like manner, with the result that an energy
30 absorption device of small overall design is produced.

- It can be provided in one development of the energy absorption device that the webs are of flexurally elastic configuration, with the result that the energy
35 absorption device mounts the vehicle element in a sprung manner.

This achieves a situation where the energy absorption device permits elastic mounting of the vehicle element as long as the deflection does not become too great. Therefore, in normal driving situations of the vehicle,
5 mounting of the vehicle element can take place, whereas an energy absorption by way of plastic deformation is realized in order to protect against a detonation effect.

10 It can be provided in one advantageous development that flexurally reinforced transition zones are configured between the fastening devices and the respective adjacent webs.

15 The configuration of the flexurally reinforced, in particular substantially flexurally rigid, transition zones achieves a situation where the webs of the energy absorption device do not simply buckle or break off, but rather a defined deformation is achieved in the
20 region of the transition deformation zones of the webs.

Furthermore, it can be provided in one development that the transition deformation zones are configured so as to adjoin the flexurally reinforced transition zones.

25 Furthermore, it can be provided that flexurally reinforced, in particular substantially flexurally rigid, corners are configured in each case between the webs.

30 This achieves a situation where the webs and not the corners experience a deformation in a targeted manner. Furthermore, a situation is achieved where the energy absorption device does not simply buckle or collapse in
35 the corners, and it is avoided that the webs lie flush on one another. The webs can therefore be subjected to bending in a targeted manner. In addition, this ensures that a plastic deformation of a deformation zone of the

web is possible, which deformation zone is arranged downstream in the resilient deflection of an elastic deformation of a web. This ensures that both sufficient elastic suspension and plastic deformation are possible.

Furthermore, it can be provided in one refinement that the deformation zones are configured so as to adjoin the flexurally reinforced corners.

Furthermore, it can be provided that, from the second fastening element toward the first fastening element, the deformation zones are configured such that they can at least partially be deformed with greater difficulty than the preceding deformation zones, with the result that the energy absorption device has a progressive deformation characteristic curve.

As a result, the deformation sequence is influenced in a targeted manner, with the result that the deformation zones are deformed in a defined sequence.

Furthermore, it can be provided that the thickness of the webs becomes greater from the second fastening element toward the first fastening element, with the result that the energy absorption device has a progressive spring characteristic curve.

This achieves a situation where the elastic deformability of the webs is of different configuration, and the spring characteristic curve of the energy absorption device can be influenced in a targeted manner.

As an alternative, the spring characteristic curve can be degressive.

Furthermore, it can be provided that the webs are arranged in a sawtooth-like manner in alternating directions.

5 As a result, a particularly space-saving energy absorption device is provided.

It can be provided in one refinement of the energy absorption device that internal radii are configured
10 between the webs in flexurally rigid corners, and/or internal radii are configured in the transition zones.

Notch stresses are induced in the deformation zones in a targeted manner by way of the configuration of
15 internal radii. The notch stress which occurs can be influenced by way of the magnitude of the radius of the internal radii, with the result that the magnitude of the notch stresses and also the limit, within which the deformation occurs, can be set by way of the radius.

20 In one advantageous development, the internal radii between the webs in the flexurally rigid corners and/or internal radii in the transition zones can become greater from the second fastening element toward the
25 first fastening element.

As a result, the deformation sequence is set in a targeted manner, with the result that a deformation occurs gradually from the second fastening element
30 toward the first fastening element.

This achieves a situation where the notch stresses are highest within the deformation zones directly on the first fastening element, and the deformation also
35 occurs first of all in the vicinity of the chassis.

As an alternative to the abovementioned sequence, however, it is also possible that the internal radii

between the webs in flexurally rigid corners and/or the internal radii in the transition zones become greater from the first fastening element toward the second fastening element. This achieves a situation where the notch stresses are highest within the deformation zones directly on the second fastening element, and the deformation occurs first of all in the vicinity of the vehicle element.

10 In the following text, the invention is to be explained on the basis of exemplary embodiments with reference to the drawings, in which:

15 fig. 1 shows a diagrammatic illustration of a first vehicle according to the invention with at least one deformation device according to the invention,

20 fig. 2 shows a diagrammatic illustration of a second vehicle according to the invention with at least one deformation device according to the invention,

25 fig. 3 shows a diagrammatic illustration of a third vehicle according to the invention with at least one deformation device according to the invention,

30 fig. 4a shows a diagrammatic illustration of an energy absorption device according to the invention in a starting position,

35 fig. 4b shows a diagrammatic illustration of the energy absorption device according to the invention in a starting position with marking of the plane E,

fig. 5 shows a diagrammatic illustration of the energy absorption device according to the invention in an intermediate position, and

5 fig. 6 shows a diagrammatic illustration of the energy absorption device according to the invention in a deformed position.

Fig. 1 shows a vehicle 1 according to the invention with a vehicle chassis 2. A vehicle element 10 is configured on the vehicle chassis 2. The vehicle 1 is preferably a military vehicle. The vehicle element 10 can be, for example, a cab, a driver's cab, a platform, a vehicle body or the like. At least one energy
10 absorption device 100 which mounts the vehicle element 10 on the vehicle 1 is arranged between the vehicle element 10 and the vehicle chassis 2.

The energy absorption device 100 serves to protect the
20 vehicle element 10 against a detonation effect and is shown in greater detail in figs. 4a to 6. The energy absorption device 100 according to figs. 4a to 6 is found in all vehicles according to figs. 1 to 3.

25 Fig. 2 shows a second vehicle 1' according to the invention which corresponds substantially to the first vehicle 1, with the difference that the vehicle element 10' is a floor or intermediate floor. The vehicle element 10' is mounted on the vehicle chassis 2 of the
30 vehicle 1 by means of at least one energy absorption device 100. The vehicle element 10' is arranged within a cab or a driver's cab.

Fig. 3 shows a third vehicle 1'' according to the
35 invention with a vehicle hull 2'. A vehicle element 10'' is mounted by means of at least one energy absorption device 100 within the vehicle hull 2'. The vehicle element 10'' can be, for example, a vehicle

interior compartment or a protective space. In a difference from fig. 3, however, the vehicle element 10'' can also be a floor or intermediate floor.

- 5 According to fig. 3, the vehicle element 10'' is connected by way of a plurality of energy absorption devices 100 to the vehicle hull 2' and is mounted within the latter.
- 10 Fig. 4a shows a diagrammatic illustration of an energy absorption device 100 according to the invention in a starting position, that is to say a position, in which the energy absorption device 100 is not deformed.
- 15 The energy absorption device 100 comprises a first fastening element 110 which can be connected to the vehicle chassis 2 or the vehicle hull 2' of the vehicle 1. The first fastening element 110 is configured as a panel or sheet and, in the installed state, is
- 20 connected to the vehicle chassis 2 or the vehicle hull 2'.
- Furthermore, the energy absorption device 100 comprises a second fastening element 120 which can be connected
- 25 to the vehicle element 10 which is to be protected. The second fastening element 110 is preferably likewise configured as a panel or plate and, in the installed state, is connected to the vehicle element 10.
- 30 The wall thickness and the dimensions of the first fastening element 110 and of the second fastening element 120 can be adapted in a manner which differs from one another to the geometry of the energy absorption device 100. As shown in fig. 1, the first
- 35 fastening element 110 can have a smaller wall thickness and can be of wider configuration than the second fastening element 120.

At least two webs 130, 140, 150, 160 are arranged between the first and the second fastening element 110, 120. In one refinement, there can be four webs 130, 140, 150, 160, as shown in fig. 4a.

5

As can be seen in fig. 4a and fig. 4b, the first fastening element 110, the second fastening element 120, the webs 130, 140, 150, 160 and the deformation zones 172, 174, 182, 184, 192, 194 are arranged in such a way that they are arranged above one another in a common plane E, the common plane E lying perpendicularly with respect to the two fastening elements 110, 120.

Here, the webs 130, 140, 150, 160 are arranged above one another in a zigzag-like manner which alternates in different directions. In other words, the webs 130, 140, 150, 160 are arranged above one another in a concertina-like manner.

20

In order to achieve sprung mounting of the vehicle element 10 by way of the energy absorption device 100, the webs 130, 140, 150, 160 are in each case of flexurally elastic configuration.

25

The length of the webs 130, 140, 150, 160 can differ from one another, with the result that, for example, a first web 130 and a fourth web 160 which are connected to the fastening elements 110, 120 are shorter than a second web 140 and third web 150.

30

The different length of the webs 130, 140, 150, 160 achieves a situation where they can compress elastically to a different extent, and the result is a defined bending shape of the energy absorption device 100 in the case of an elastic deformation. A bending shape of this type as a consequence of an elastic deformation is shown in fig. 5, for example.

35

Flexurally reinforced corners 170, 180, 190 are configured in each case between the webs 130, 140, 150, 160. The flexurally reinforced corners 170, 180, 190 are configured in such a way that they substantially do not bend and ensure that, in the case of an elastic deformation of the webs 130, 140, 150, 160, the flexurally reinforced corners 170, 180, 190 ensure that the webs 130, 140, 150, 160 are not folded up by way of deformation of the corners 170, 180, 190. This achieves a situation where, in addition to an elastic deformation, a plastic deformation of the deformation zones 172, 174, 182, 184, 192, 194 can take place in the case of a relatively pronounced deflection.

As shown in fig. 4a, the webs 130, 140, 150, 160 in each case have at least one deformation zone 172, 174, 182, 184, 192, 194. The deformation zones 172, 174, 182, 184, 192, 194 are configured in each case so as to adjoin the flexurally reinforced corners 170, 180, 190.

Flexurally reinforced transition zones 112, 122 are configured between the fastening means 110, 120 and the respective adjoining webs 130, 160. Said transition zones have a comparable effect to the flexurally reinforced corners 170, 180, 190.

The transition deformation zones 115, 125 are configured so as to adjoin the flexurally reinforced transition zones 112, 122.

As shown in fig. 4a, internal radii R_2 , R_3 , R_4 are configured between the webs 130, 140, 150, 160 in the deformation zones 172, 174, 182, 184, 192, 194, and/or internal radii R_1 , R_5 are configured in the transition zones 112, 122.

According to figure 4a, the internal radii R_2 , R_3 , R_4 which are configured between the webs 130, 140, 150, 160 in the flexurally rigid corners 170, 180, 190 become greater from the second fastening element 120 toward the first fastening element 110.

In one refinement, a fourth radius R_4 between the third web 150 and the fourth web 160 is the greatest. A third radius R_3 between the second web 140 and the third web 150 is smaller than the fourth radius ($R_3 < R_4$). A second radius R_2 between the first web 130 and the second web 140 is smaller than the third radius R_3 . The following mathematical relationship applies to the radii R_2 to R_4 : $R_2 < R_3 < R_4$.

According to fig. 4a, the internal radii R_1 , R_5 in the transition zones 112, 122 are preferably configured so as to be equally great. As is apparent from fig. 4a, the radii R_1 and R_5 are both smaller than the radius R_2 . The following mathematical relationship applies to the radii R_1 to R_5 : $R_1 = R_5 < R_2 < R_3 < R_4$.

The thickness t_1 , t_2 , t_3 , t_4 of the webs 130, 140, 150, 160 can be configured so as to be greater from the second fastening element 120 toward the first fastening element 110, with the result that the energy absorption device 100 has a progressive spring characteristic curve. The following mathematical relationship applies to the thicknesses t_1 to t_4 : $t_1 < t_2 < t_3 < t_4$.

Fig. 4b once again clearly illustrates the position of the plane E, the plane E being identified in a hatched manner. As can be seen from fig. 4b, the plane E lies perpendicularly with respect to the first and the second fastening element 110, 120. The first fastening element 110, the second fastening element 120, the at least two webs 130, 140, 150, 160 and the at least one deformation zone 172, 174, 182, 184, 192, 194 are

arranged in such a way that they lie above one another in the plane E.

Fig. 5 shows a diagrammatic illustration of the energy absorption device 100 according to the invention in an intermediate position, in which the energy absorption device 100 is deformed elastically. The flexurally rigid corners 170, 180, 190 are substantially non-deformed in this intermediate position, and the webs 130, 140, 150, 160 are deformed elastically. Fig. 5 therefore shows the energy absorption device 100 in an elastically compressed state.

Fig. 6 shows a diagrammatic illustration of the energy absorption device 100 according to the invention in a deformed position, in which the energy absorption device 100 is deformed plastically.

From the second fastening element 120 toward the first fastening element 110, the deformation zones 172, 174, 182, 184, 192, 194 are configured such that they can at least partially be deformed with greater difficulty than the preceding deformation zones 172, 174, 182, 184, 192, 194, with the result that the energy absorption device 100 has a progressive deformation characteristic curve. In addition, a deformation sequence of the deformation zones of the energy absorption device 100 is specified by way of the deformation which is pronounced to different extents.

30

In so far as the preceding disclosure relates to an energy absorption device 100 per se, this is also considered at the same time to be disclosed for a vehicle with an energy absorption device 100 of this type.

35

LIST OF DESIGNATIONS

	1	First vehicle
	1'	Second vehicle
5	1''	Third vehicle
	2	Vehicle chassis
	2'	Vehicle hull
	10	Vehicle element
	10'	Vehicle element
10	10''	Vehicle element
	100	Energy absorption device
	110	First fastening element
	112	First transition zone
	115	First transition deformation zone
15	120	Second fastening element
	122	Second transition zone
	125	Second transition deformation zone
	130	First web
	140	Second web
20	150	Third web
	160	Fourth web
	170	First deformation zone
	180	Second deformation zone
	190	Third deformation zone
25	R ₁	First radius
	R ₂	Second radius
	R ₃	Third radius
	R ₄	Fourth radius
30	R ₅	Fifth radius
	E	Plane
	t ₁	Thickness of the first web
	t ₂	Thickness of the second web
	t ₃	Thickness of the third web
35	t ₄	Thickness of the fourth web

PATENT CLAIMS

1. An energy absorption device (100) for protecting a vehicle element (10, 10', 10''), in particular of a military vehicle (1', 1', 1''), against a detonation effect, comprising
a first fastening element (110) which can be connected to a vehicle chassis (2) and/or a vehicle hull (2), and a second fastening element (120) which can be connected to the vehicle element (10, 10', 10'') which is to be protected,
at least two webs (130, 140, 150, 160) being arranged between the first and the second fastening element (110, 120),
characterized in that
the at least two webs (130, 140, 150, 160) are arranged in such a way that they lie above one another in a common plane (E).
2. The energy absorption device (100) as claimed in claim 1, characterized in that the webs (130, 140, 150, 160) have at least one deformation zone (172, 174, 182, 184, 192, 194).
3. The energy absorption device (100) as claimed in claim 2, characterized in that the first fastening element (110), the second fastening element (120), the at least two webs (130, 140, 150, 160) and the at least one deformation zone (172, 174, 182, 184, 192, 194) are arranged in such a way that they lie above one another in the plane (E) which lies perpendicularly with respect to the first and the second fastening element (110, 120).
4. The energy absorption device (100) as claimed in one of the preceding claims, characterized in that the webs (130, 140, 150, 160) are of resiliently flexible configuration.

5. The energy absorption device (100) as claimed in one of the preceding claims, characterized in that flexurally reinforced transition zones (112, 122) are configured between the fastening means (110, 120) and the respective adjoining webs (130, 160).

6. The energy absorption device (100) as claimed in claim 5, characterized in that transition deformation zones (115, 125) are configured so as to adjoin the flexurally reinforced transition zones (112, 122).

7. The energy absorption device (100) as claimed in one of the preceding claims, characterized in that flexurally reinforced corners (170, 180, 190) are configured in each case between the webs (130, 140, 150, 160).

8. The energy absorption device (100) as claimed in claim 7, characterized in that the deformation zones (172, 174, 182, 184, 192, 194) are configured so as to adjoin the flexurally reinforced corners (170, 180, 190).

9. The energy absorption device (100) as claimed in one of claims 2 to 8, characterized in that, from the second fastening element (120) toward the first fastening element (110), the deformation zones (172, 174, 182, 184, 192, 194) are configured such that they can at least partially be deformed with greater difficulty than the preceding deformation zones (172, 174, 182, 184, 192, 194), with the result that the energy absorption device (100) has a progressive deformation characteristic curve.

35

10. The energy absorption device (100) as claimed in one of the preceding claims, characterized in that the thickness (t_1 , t_2 , t_3 , t_4) of the webs (130, 140, 150,

160) becomes greater from the second fastening element (120) toward the first fastening element (110), with the result that the energy absorption device (100) has a progressive spring characteristic curve.

5

11. The energy absorption device (100) as claimed in one of the preceding claims, characterized in that the webs (130, 140, 150, 160) are arranged in a sawtooth-like manner in alternating directions.

10

12. The energy absorption device (100) as claimed in one of the preceding claims, characterized in that internal radii (R_2 , R_3 , R_4) are configured between the webs (130, 140, 150, 160) in the flexurally rigid corners (170, 180, 190), and/or internal radii (R_1 , R_5) are configured in the transition zones (112, 122).

13. The energy absorption device (100) as claimed in one of claims 7 to 12, characterized in that the internal radii (R_2 , R_3 , R_4) between the webs (130, 140, 150, 160) in the flexurally rigid corners (170, 180, 190) and/or internal radii (R_1 , R_5) in the transition zones (112, 122) become greater from the second fastening element (120) toward the first fastening element (110).

14. A vehicle (1, 1', 1'') comprising an energy absorption device (100) as claimed in one of claims 1 to 13 and a vehicle element (10, 10', 10''), the vehicle element (10, 10', 10'') being connected via the energy absorption device (100) to the vehicle (1, 1', 1'').

15. The vehicle (1, 1', 1'') as claimed in claim 14, the vehicle element (10, 10', 10'') being a cab, in particular a vehicle cab, a floor, an intermediate floor, a vehicle body, a foot plate, a seat means, a weapons system, a device mount or a shelf.