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(54) CRASH CUSHION

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(56) References cited:
AU-A4- 2011 101 435
DE-A1-102011 055 960
DE-U- 1 943 439
FR-A1- 2 748 763
GB-A- 2 508 217
US-A1- 2014 312 289

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Description

TECHNICAL FIELD

[0001] The object of the invention is a post-type crash cushion.

BACKGROUND

[0002] A crash cushion is an energy-absorbing, point type road safety device which is mounted in front of non-susceptible obstacles in order to reduce the intensity of the impact. A crash cushion is divided into redirective crash cushions and non-redirective crash cushions. The purpose of redirective crash cushions is to prevent the vehicle from colliding with an obstacle and to change its direction of travel. Non-redirective crash cushions are intended to stop the hitting vehicle without changing its direction of travel. With regard to the maximum velocity of the hitting vehicle, the four classes of cushion operation are provided, namely 50, 80, 100 and 110, the designation of which corresponds to the velocity of impact. With regard to the level of intensity of the impact, the cushions are classified into classes A and B. Class A cushions are those for which the ASI (Acceleration Severity Index) parameter shall not exceed 1, while for Class B cushions the ASI shall not exceed 1.4.

[0003] A US patent US3881697 discloses a device protecting a vehicle against collision with a fixed obstacle, e.g. a road lamp. The device consists of a base placed on the ground in the form of a plate extending towards the obstacle and a set of vertical posts mounted on the base. The height and number of the posts shall be increased towards the obstacle. The posts absorb the energy of the hitting vehicle due to bending.

[0004] A US patent US4290585 discloses a device for stopping the vehicle in front of an obstacle. The device consists of a set of vertical posts. Each post consists of an upper and lower part. The lower part is a pipe set in the ground, while the upper part is a pipe closed at its top side filled with foam material. The foam has a blind hole along the axis of the pipe. The upper and lower part of the post are connected by means of a cylindrical connector consisting of two sections of different diameters separated by a flange. The larger diameter section of the connector is placed in the lower pipe so that the connector flange rests against the ground. The top section of the connector is covered with an upper pipe. During the impact, the upper pipe together with the foam is compressed and the connector is sheared at the height of the flange. The posts forming the device are connected by chains which prevent free movement of the upper part of the post after it is sheared.

[0005] A US patent US6454488 discloses a device absorbing energy of the hitting vehicle. The device consists of multiple posts of equal length, arranged in a row with a fixed distance between the posts. The posts are placed in a base which is a cuboidal block recessed in the ground. In the preferred embodiment of the invention, the posts have a U-shaped cross-section and round holes in the rear wall, which causes them to be sheared at the base during the vehicle impact and then to be rejected.

[0006] A US patent US3693940 discloses a barrier system for stopping the vehicle. The system consists of a set of vertical posts. When the post is tilted from the vertical, the energy of the hitting vehicle is absorbed by the damper inside the post. The posts absorb energy only up to a certain angle of inclination, above which they overturn with little force, thus preventing unwanted lifting of the vehicle.

[0007] GB2508127 - discloses a- bollard assembly that comprises a sleeve for setting into the ground and a bollard which engages into the sleeve. The bollard includes two portions which extend upwardly from the ground, the portions connected such that the central longitudinal axes of the portions form at least an acute angle in the range 35 and 55 degrees. The bollard assembly protects buildings by providing a compelling deterrent to would-be ram raid thieves. Typically, the second portion is installed angled towards a building or other protected structure. If a vehicle is driven at the bollard in attempt to break the bollard down, the front wheels of the vehicle will be lifted off the ground. The vehicle will travel up and over the bollard.

[0008] The purpose of the invention is to present a post type crush cushion, the design of which prevents the vehicle from lifting when it enters previously slanted posts.

SUMMARY

[0009] The object of the invention is a crash cushion according to the appended claims.

[0010] The crash cushion absorbs the kinetic energy of the hitting vehicle due to deformation of the posts, which are subjected to bending. Hitting successive posts in a row by a vehicle causes gradual reduction of its velocity. The vehicle is stopped completely if a sufficient number of posts is used. The disadvantage of the post-type crash cushions is to raise the vehicle entering the previously inclined posts. This phenomenon reduces the effectiveness of the cushion as the subsequent posts are hit at a higher height and the final angle of inclination of the posts becomes smaller and smaller. As a result, the force required to tilt the posts and the energy of their deformation decreases for the subsequent posts. In extreme cases, the vehicle may rise above the last posts. The consequence of lifting the vehicle may be its rollover or passing over the end of the cushion ended by hitting an obstacle (e.g. a tree). In the patent descriptions cited, the problem of lifting the vehicle is solved by: (a) the use of posts that are sheared at the base and then thrown away; (b) the use of posts which after tilting from the vertical by a certain angle overturn with a minimum force; (c) the use of posts of different heights so that the posts closer to the obstacle have a higher height. In the inven-

tion presented, the inclination of the upper section of the posts which is the essential component of the crash cushion prevents the vehicle from being raised. The front bumper of the vehicle shall tilt the lower section of the posts due to bending. At the same time, the vehicle drives under the upper section inclined forward, hitting it with the bonnet and/or bumper, causing it to hit the ground and not to lift. The inclination of the upper section makes the vehicle hitting the subsequent posts at a height close to that of hitting the first posts, thus making the force and energy required to incline the subsequent posts comparable. This ensures optimal use of the posts to stop the vehicle.

[0011] After connecting the posts to the rectangular bases with holes, it is possible to fix the cushion with the anchors to a concrete foundation set in the ground. An alternative option to install the cushion is to drive it directly into the ground after using the posts with an extended lower section. Such a solution is particularly advantageous in the case of mounting the cushion in front of the trees, where the construction of the foundation could disturb the root system of the trees. In the preferred version of the invention, the cushion consists of two rows of posts, where the posts at one height in both rows are connected by upper sections forming a straight, broken or curvilinear connector. This increases the operation width of the cushion and stabilizes its operation. In addition, the connector provides a greater effect of the vehicle's hitting. The connected thin-walled posts with ring cross-section can be made from a single pipe section in the bending process, significantly reducing cushion manufacturing costs. In turn, the connection of the posts with the connector with the shape of circle section reduces the number of bending operations from four to three, while increasing the bending radius, which further simplifies the production of a single cushion module.

[0012] The installation of double posts connected by upper sections can be done by screwing them to the foundation with anchors or by driving them directly into the ground. In the case of the second solution, it is preferable to connect the posts with a horizontal retaining crossbar below ground level. By leaning against the ground, the crossbar prevents the part of the post that has been driven into the ground, from moving. In addition, the crossbar is a point of impact for pile drivers and vibratory pile hammers when driving the posts into the ground.

[0013] The revealed design of the cushion meets the requirements for the redirective cushion after connecting the lower sections with the ties, which in the case of a side impact change the direction of vehicle movement.

[0014] The solution according to the invention where the crash cushion consists of post with a sloping upper section allows the vehicle to be stopped without lifting.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The invention is shown in the embodiments in which fig. 1 represents a post fixed to the foundation and a post driven into the ground in a projection on a vertical plane passing through the longitudinal axis of the cushion, fig. 2 represents a crash cushion consisting of a row of posts and a cushion consisting of two rows of posts, figs. 3 represents a cushion consisting of two rows of posts joined by upper sections and attached to the foundation and a cushion consisting of two rows of posts joined by upper sections and driven into the ground, fig. 4 represents a cushion consisting of two rows of posts whose upper sections form a connector in the shape of a circle section, fig. 5 represents a cushion in a redirective version, fig. 6 represents the vehicle hitting against the crash cushion consisting of one row of straight posts and the vehicle hitting against the crash cushion consisting of one row of posts ended with an inclined upper section, fig. 7 represents the crash cushion mounted before the entrance to the tunnel, figs. 8 represents the crash cushion mounted in front of a tree, fig. 9 represents a crash cushion mounted at a road fork.

DETAILED DESCRIPTION

[0016] The crash cushion in the preferred embodiment of the invention consists of eight posts 1 arranged in two rows, the posts from both rows are mounted at equal distance from the obstacle and are connected by upper sections 1a forming a straight connector 6. The connected posts at the same distance from the obstacle form a cushion module, so the cushion consists of four independent modules. Posts 1 are ended with a rectangular base 2, in which holes for anchors 3 are made to fix the cushion to the concrete foundation 4 set in the ground 5. The distance between adjacent posts in one row *L* is 1000 mm. The width of the cushion *W,* i.e. the distance between the adjacent posts in both rows, is 500 mm. A single 820 mm high post consists of an upper section 1a and a lower section 1b. The lower section 1b is vertical to the ground and its height *h* is 600 mm. The upper section 1a with the length *l* is inclined towards the oncoming vehicle so that the angle α between upper section 1a and lower section 1b is 130°. The base cushion module consisting of two posts connected by a connector is made of one section of S235 steel pipe by bending. The diameter of the posts is 115 mm. The total length and weight of the cushion is 3300 mm and 140 kg respectively. The cushion enables a vehicle with a mass of 900 kg and a speed of 100 km/h to be stopped with ASI B.

[0017] The crash cushion, according to the invention, can be used to prevent collision with rigid objects in the vicinity of roads, e.g. poles, pylons, masts or trees. Due to its short length, adjustable width and the possibility of driving directly into the ground, the crash cushion can be used in front of obstacles in front of which classic crash cushions cannot be used due to limited space or the impossibility of making a foundation. Its modular and open design ensures high susceptibility to diagnostics, maintenance and repair. In the case of the cushion entering upon by a vehicle with a lower weight or speed, only part

of the modules are destroyed, which can be replaced without interfering with the rest of the cushion.

Claims

1. A crash cushion comprising a row of posts (1) arranged in front of an obstacle, for absorbing kinetic energy of an oncoming vehicle by deformation of the posts subjected to bending, **characterized in that** each post (1) is divided into an upper section (1a) and a lower section (1b), the upper section (1a) being straight, broken or curved, so that when the post (1) is projected into a vertical plane (Vp) passing through a longitudinal axis of the cushion (La), an angle (α) between the upper section (1a) and the lower section (1b) is between 5° and 175°, a height (h) of the lower section (1b) is between 300 mm and 1200 mm, and a length (1) of the upper section (1a) is between 100 mm and 1000 mm and a distance (L) between adjacent posts (1) within the row is between 300 mm and 2000 mm, wherein the posts (1) are arranged within the row with their upper section (1a) inclined away from the obstacle.

2. The crash cushion according to claim 1, **characterised in that** the posts (1) are arranged in two rows in front of the obstacle, where the corresponding posts (1) in both rows are at equal distance from the obstacle, the width of the crash cushion *W* is between 100 mm and 2500 mm, and the distance between the adjacent posts in a row L is between 300 mm to 2000 mm.

3. The crash cushion according to claim 1, **characterised in that** the post (1) is ended with a base (2) in the form of a rectangular plate with holes for anchors (3).

4. The crash cushion according to claim 1 or 3, **characterised in that** the post (1) is fixed to a concrete foundation (4) embedded in the ground (5).

5. The crash cushion according to claim 1, **characterised in that** the lower section of the post (1b) is elongated by a section with the length *g* equal at least to 300 mm, which is driven into the ground (5).

6. The crash cushion according to claim 1 and 2, **characterised in that** the adjacent posts (1) from both rows are connected by upper sections (1a) forming a straight, broken or curvilinear connector (6).

7. The crash cushion according to claim 1, 2 and 6, **characterised in that** two connected posts (1) are made of one section of pipe in the bending process.

8. The crash cushion according to claim 1, 2 and 6, **characterised in that** the upper sections (1a) of the connected posts (1) have the shape of a section of a circle.

9. The crash cushion according to claim 1, 2, 5 and 6, **characterised in that** the adjacent posts (1) from both rows are connected by a horizontal retaining crossbar below ground level (5).

10. The crash cushion according to claim 1, **characterised in that** the lower sections of the posts (1b) are connected by at least one tie (7) in the form of rope, chain, belt, bar or tape.

Patentansprüche

1. Ein Aufpralldämpfer mit einer Reihe von Pfosten (1), die vor einem Hindernis angeordnet sind, um die kinetische Energie eines ankommenden Fahrzeugs durch Verformung der Pfosten unter Biegung zu absorbieren, **dadurch gekennzeichnet, dass** jeder Pfosten (1) in einen oberen Abschnitt (1a) und einen unteren Abschnitt (1b) unterteilt ist, wobei der obere Abschnitt (1a) gerade, gebrochen oder gekrümmt ist, so dass, wenn der Pfosten (1) in eine vertikale Ebene (Vp) projiziert wird, die durch eine Längsachse des Dämpfers (La) verläuft, ein Winkel (a) zwischen dem oberen Abschnitt (1a) und dem unteren Abschnitt (1b) zwischen 5° und 175° beträgt, eine Höhe (h) des unteren Abschnitts (1b) zwischen 300 mm und 1200 mm liegt und eine Länge (1) des oberen Abschnitts (1a) zwischen 100 mm und 1000 mm liegt und ein Abstand (L) zwischen benachbarten Pfosten (1) innerhalb der Reihe zwischen 300 mm und 2000 mm beträgt, wobei die Pfosten (1) innerhalb der Reihe mit ihrem oberen Abschnitt (1a) vom Hindernis weg geneigt angeordnet sind.

2. Der Anpralldämpfer nach Anspruch 1, **dadurch gekennzeichnet, dass** die Pfosten (1) in zwei Reihen vor dem Hindernis angeordnet sind, wobei die entsprechenden Pfosten (1) in beiden Reihen den gleichen Abstand zum Hindernis haben, die Breite des Anpralldämpfers W zwischen 100 mm und 2500 mm liegt und der Abstand zwischen den benachbarten Pfosten in einer Reihe L zwischen 300 mm und 2000 mm beträgt.

3. Der Anpralldämpfer nach Anspruch 1, **dadurch gekennzeichnet, dass** der Pfosten (1) mit einer Basis (2) in Form einer rechteckigen Platte mit Löchern für Anker (3) endet.

4. Der Anpralldämpfer nach Anspruch 1 oder 3, **dadurch gekennzeichnet, dass** der Pfosten (1) an einem in den Boden (5) eingelassenen Betonfundament (4) befestigt ist.

5. Der Anpralldämpfer nach Anspruch 1, **dadurch gekennzeichnet, dass** der untere Abschnitt des Pfostens (1b) durch einen Abschnitt mit der Länge g von mindestens 300 mm verlängert ist, der in den Boden (5) getrieben wird.

6. Der Anpralldämpfer nach Anspruch 1 und 2, **dadurch gekennzeichnet, dass** die benachbarten Pfosten (1) der beider Reihen durch obere Abschnitte (1a) verbunden sind, die eine gerade, gebrochene oder gekrümmte Verbindung (6) bilden.

7. Der Anpralldämpfer nach Anspruch 1, 2 und 6, **dadurch gekennzeichnet, dass** zwei miteinander verbundene Pfosten (1) im Biegeverfahren aus einem Rohrabschnitt gefertigt werden.

8. Der Anpralldämpfer nach Anspruch 1, 2 und 6, **dadurch gekennzeichnet, dass** die oberen Abschnitte (1a) der verbundenen Pfosten (1) die Form eines Kreisabschnitts haben.

9. Der Anpralldämpfer nach Anspruch 1, 2, 5 und 6, **dadurch gekennzeichnet, dass** die benachbarten Pfosten (1) beider Reihen durch eine horizontale Haltetraverse unterhalb des Bodenniveaus (5) verbunden sind.

10. Der Anpralldämpfer nach Anspruch 1, **dadurch gekennzeichnet, dass** die unteren Abschnitte der Pfosten (1b) durch mindestens eine Verbindung (7) in Form eines Seils, einer Kette, eines Gurtes, einer Stange oder eines Bands verbunden sind.

Revendications

1. Un amortisseur d'impact comprenant une rangée de poteaux (1) disposés devant un obstacle, pour absorber l'énergie cinétique d'un véhicule entrant par déformation des poteaux soumis à une flexion, **caractérisé en ce que** chaque poteau (1) est divisé en une section supérieure (1a) et une section inférieure (1b), la section supérieure (1a) étant droite, brisée ou incurvée, de sorte que lorsque le poteau (1) est projeté dans un plan vertical (Vp) passant par un axe longitudinal de l'amortisseur (La), un angle (a) entre la section supérieure (1a) et la section inférieure (1b) est compris entre 5° et 175°, une hauteur (h) de la section inférieure (1b) est comprise entre 300 mm et 1200 mm, et une longueur (1) de la section supérieure (1a) est comprise entre 100 mm et 1000 mm et une distance (L) entre des poteaux adjacents (1) à l'intérieur de la rangée est comprise entre 300 mm et 2000 mm, dans lequel les poteaux (1) sont disposés à l'intérieur de la rangée avec leur section supérieure (1a) inclinée à l'écart de l'obstacle.

2. L'amortisseur d'impact selon la revendication 1, **caractérisé en ce que** les poteaux (1) sont disposés en deux rangées devant l'obstacle, où les poteaux correspondants (1) des deux rangées sont à égale distance de l'obstacle, la largeur de l'amortisseur d'impact W est comprise entre 100 mm et 2500 mm, et la distance entre les poteaux adjacents d'une rangée L est comprise entre 300 mm et 2000 mm.

3. L'amortisseur d'impact selon la revendication 1, **caractérisé en ce que** le poteau (1) est terminé par une base (2) sous la forme d'une plaque rectangulaire avec des trous pour des ancrages (3).

4. L'amortisseur d'impact selon la revendication 1 ou 3, **caractérisé en ce que** le poteau (1) est fixé à une fondation en béton (4) noyée dans le sol (5).

5. L'amortisseur d'impact selon la revendication 1, **caractérisé en ce que** la section inférieure du poteau (1b) est allongée par une section dont la longueur g est au moins égale à 300 mm, qui est enfoncée dans le sol (5).

6. L'amortisseur d'impact selon les revendications 1 et 2, **caractérisé en ce que** les poteaux adjacents (1) des deux rangées sont reliés par des sections supérieures (1a) formant un connecteur (6) droit, brisé ou curviligne.

7. L'amortisseur d'impact selon les revendications 1, 2 et 6, **caractérisé en ce que** deux poteaux (1) reliés sont fabriqués à partir d'une seule section de tuyau lors du processus de cintrage.

8. L'amortisseur d'impact selon la revendication 1, 2 et 6, **caractérisé en ce que** les sections supérieures (1a) des poteaux reliés (1) ont la forme d'une section de cercle.

9. L'amortisseur d'impact selon la revendication 1, 2, 5 et 6, **caractérisé en ce que** les poteaux adjacents (1) des deux rangées sont reliés par une traverse de retenue horizontale sous le niveau du sol (5).

10. L'amortisseur d'impact selon la revendication 1, **caractérisé en ce que** les sections inférieures des poteaux (1b) sont reliées par au moins un lien (7) sous forme de corde, chaîne, ceinture, barre ou ruban.

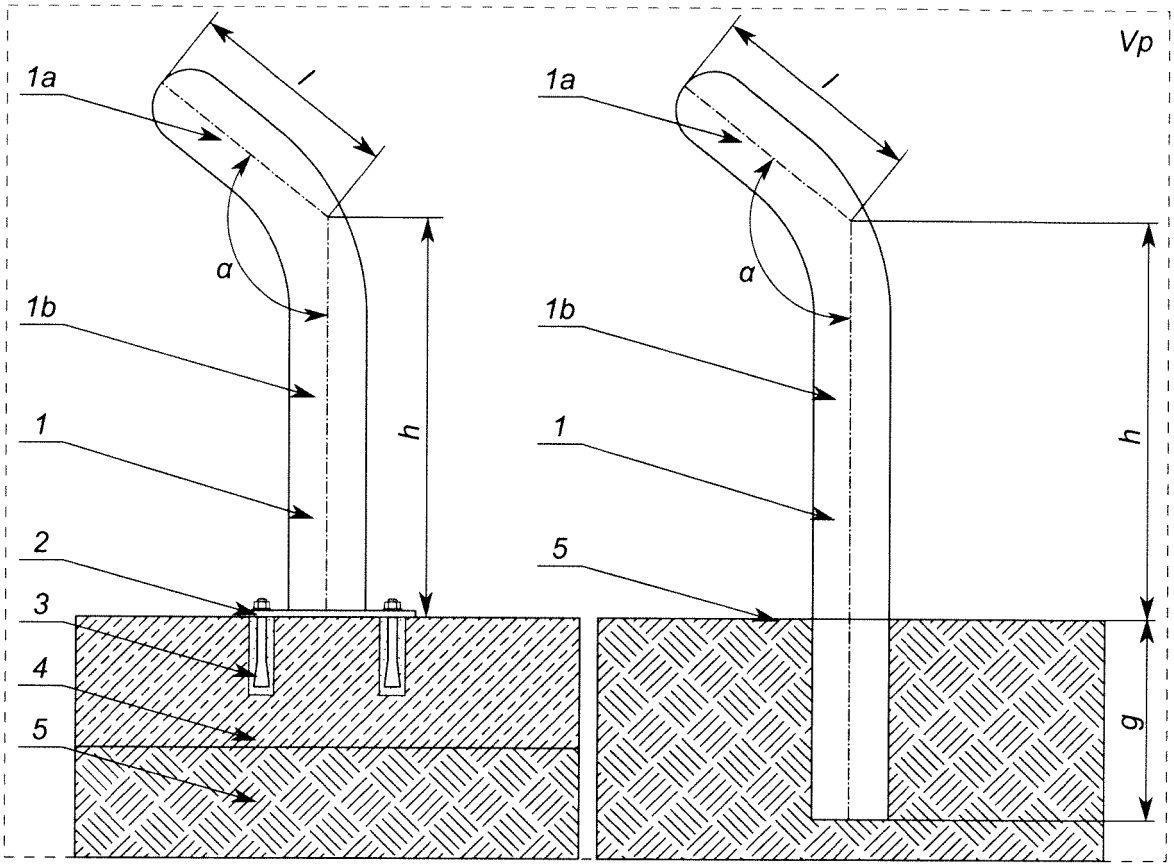


Fig. 1

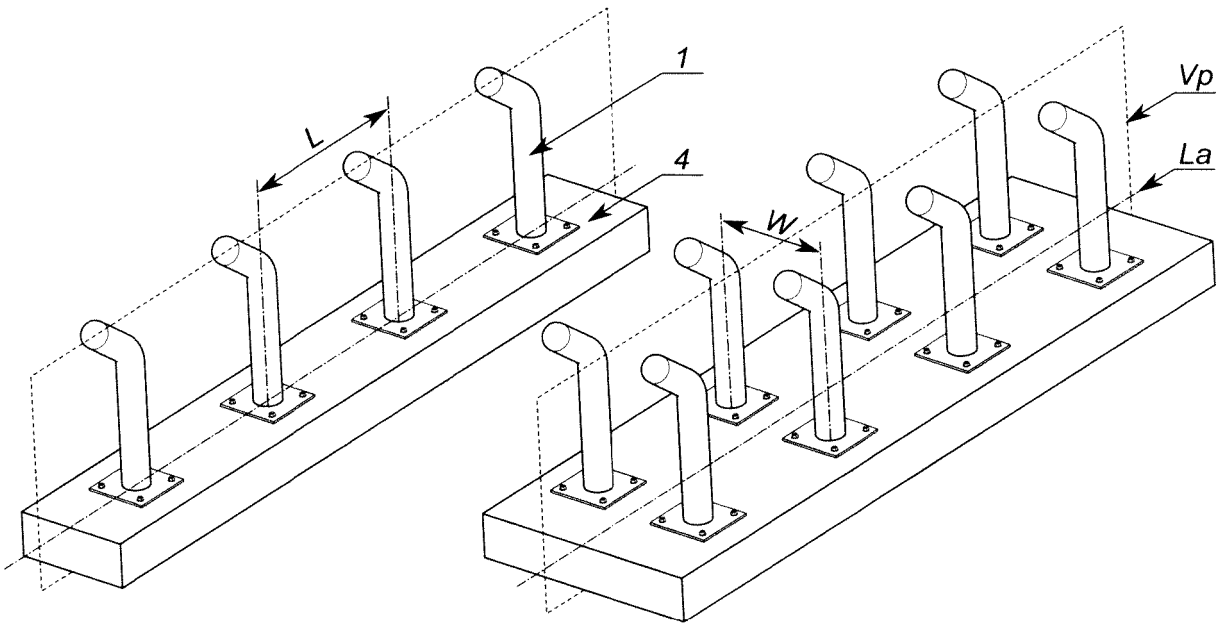


Fig. 2

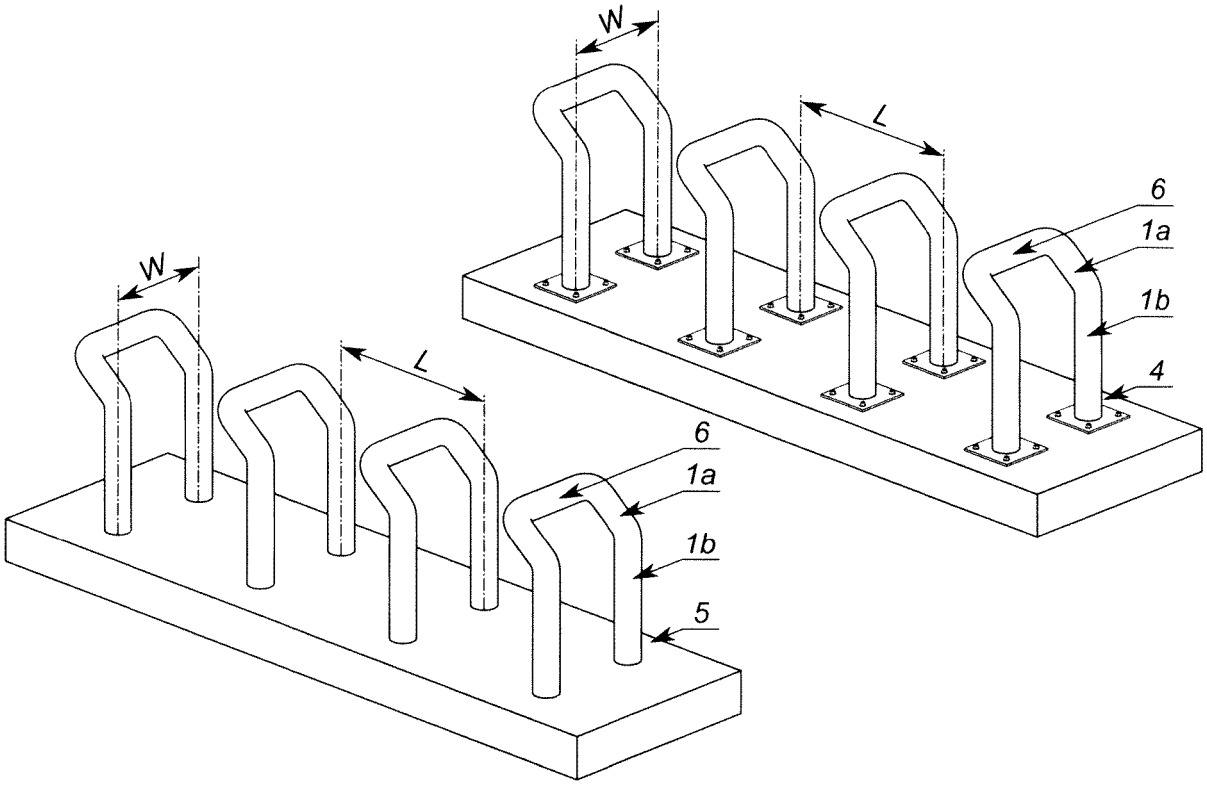


Fig. 3

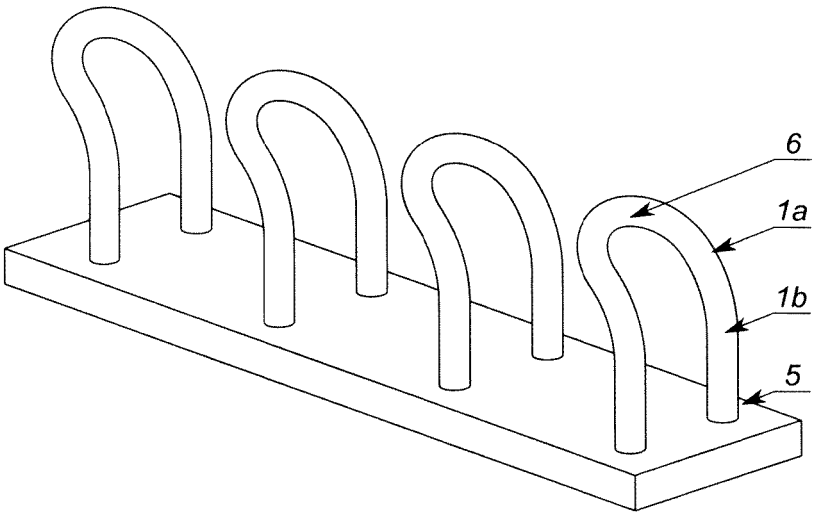


Fig. 4

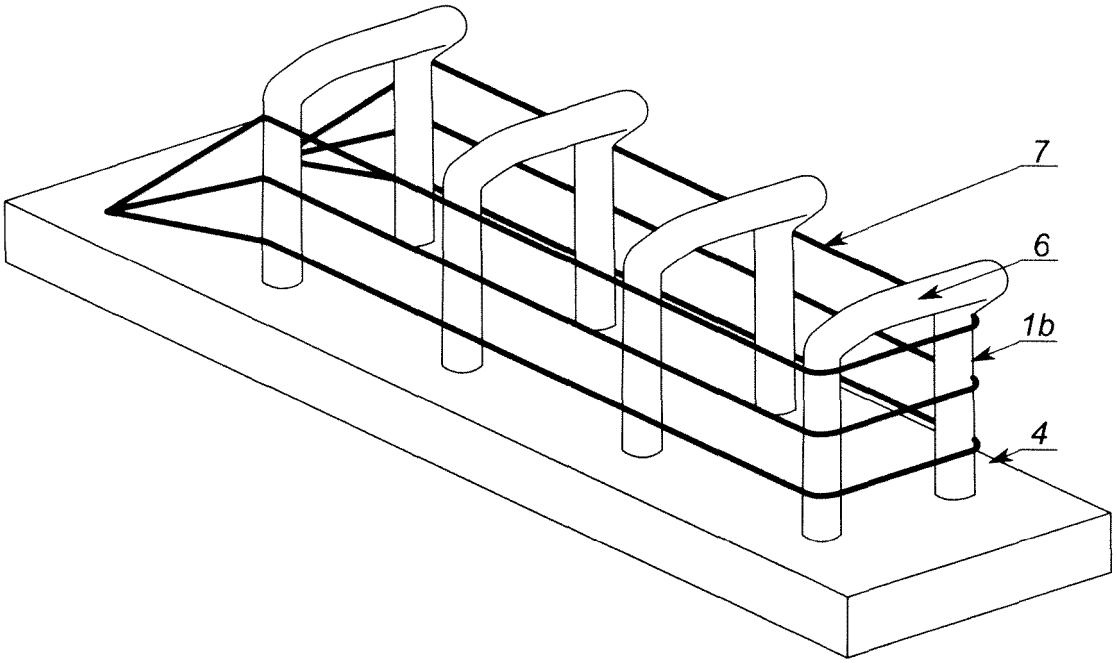


Fig. 5

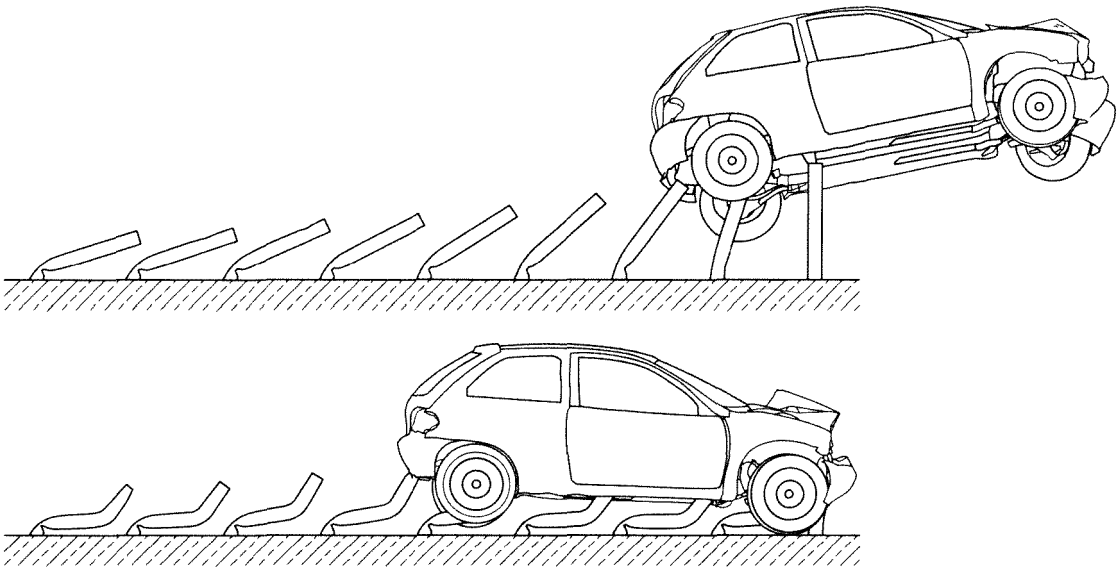


Fig. 6

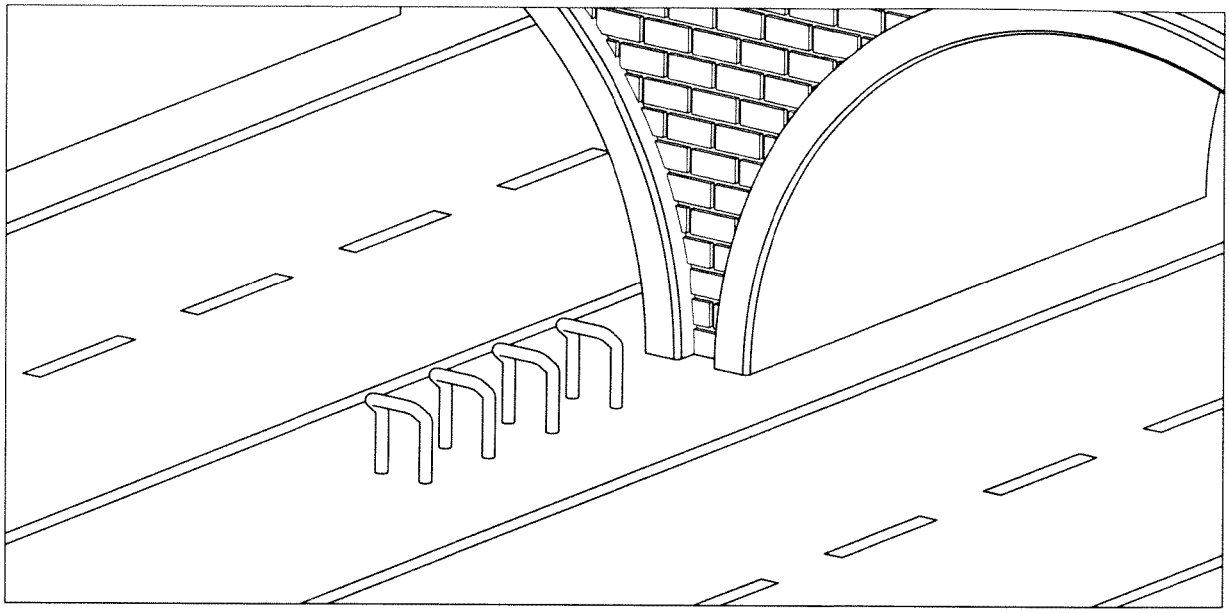


Fig. 7

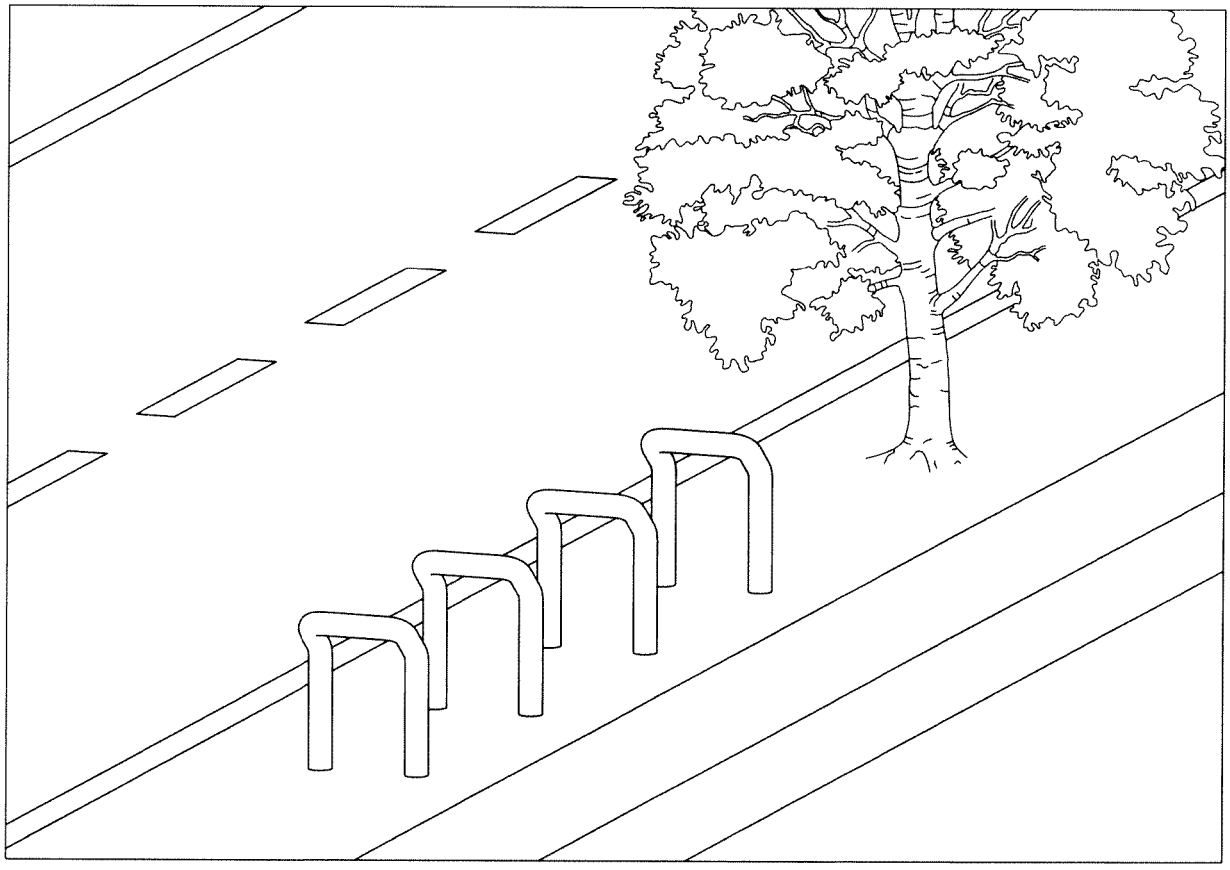


Fig. 8

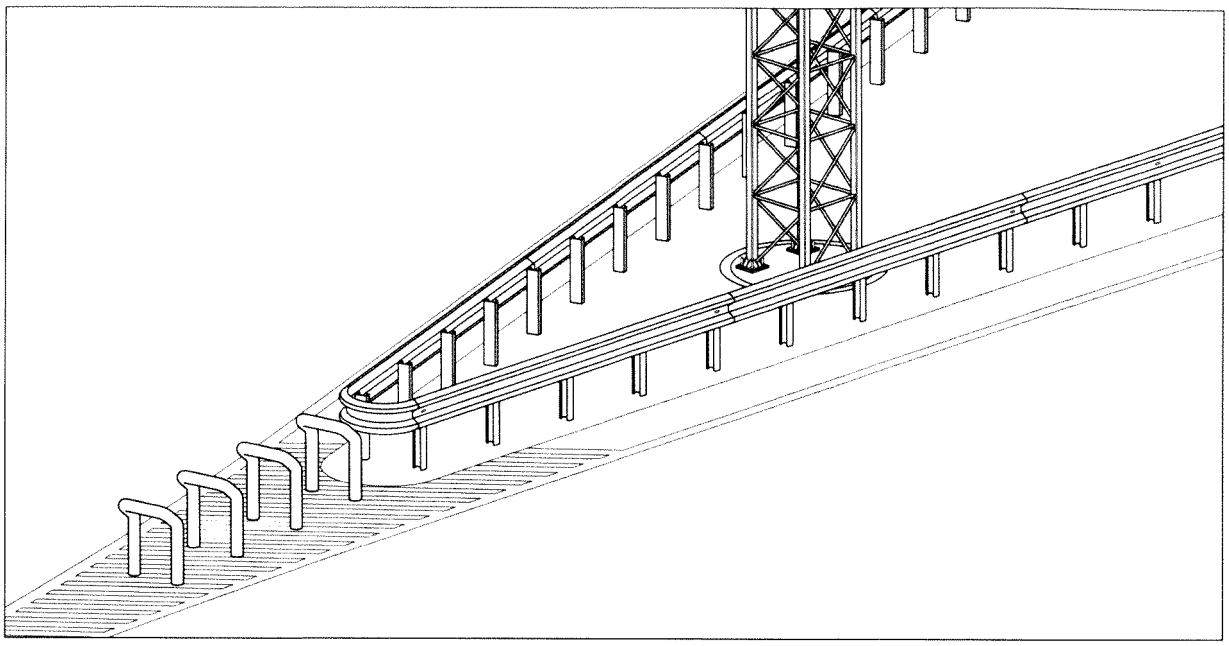


Fig. 9

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 3881697 A **[0003]**
- US 4290585 A **[0004]**
- US 6454488 B **[0005]**
- US 3693940 A **[0006]**
- GB 2508127 A **[0007]**