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(54) ROAD SAFETY BARRIER WITH A PLURALITY OF METAL CABLES

STRASSENSCHUTZBARRIERE MIT MEHREREN METALLKABELN

BARRIÈRE DE SÉCURITÉ ROUTIÈRE AVEC UNE PLURALITÉ DE CÂBLES MÉTALLIQUES

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to the technical sector concerning road safety devices, and in greater detail relates to road safety barriers with a plurality of metal cables.

DESCRIPTION OF THE PRIOR ART

[0002] In general, a road safety barrier is installed along the side of the carriageway to contain and re-direct vehicles in a case of an impact. The road safety barrier is, in fact, designed for absorbing a part of the kinetic energy possessed by the vehicle during the impact step, as it deforms, and so that the vehicle, following the impact, does not pass beyond the road safety barrier but is re-directed onto the carriageway, so as to minimise the effects induced both on the occupants of the impacting vehicle and on the occupants of other vehicles that might be present in the vicinity.

[0003] Road safety barriers with metal cables supported by poles are known from, for example, US 2013/069026 A.

[0004] In particular, a road safety barrier (100) with a plurality of metal cables is known, with a plurality of metal cables (104), see figures 1 and 2, comprising: a plurality of poles (102) which are fixed to the ground (103), which are distanced from one another and which are arranged one following another along the side of a carriageway (not illustrated); a plurality of metal cables (104) which are supported by the poles (102) of the plurality of poles (102), so that each metal cable (104) of the plurality of metal cables (104) is parallel to and at a predefined distance from the remaining metal cables (104) of the plurality of metal cables (104).

[0005] The metal cables (104) of the plurality of metal cables (104) are fixed to bases (not illustrated) at the relative ends and can even be hundreds of metres long. Each pole (102) of the plurality of poles (102) can be a C-shaped profiled member comprising a central plate (105) and two lateral wings (106); the central plate (105) is provided with a plurality of through-holes (not visible in figures 1 and 2) arranged at different heights; each through-hole of the plurality of through-holes is dimensioned to enable the sliding of a metal cable (104) of the plurality of metal cables (104).

[0006] In the case of an impact of a vehicle against the road safety barrier (100), described in the foregoing, some poles (102) of the plurality of poles (102) are knocked down, becoming deconstrained from the ground (103), while the metal cables (104) of the plurality of metal cables (104) are placed in traction and deform by lengthening and sliding at the same time along the through-holes of the poles (102) of the plurality of poles (102). The lengthening of the metal cables (104) can be of some metres, if as specified above the metal cables (104) have a length of hundreds of metres. Therefore, in the impact zone the road safety barrier (100) forms a bend having a bellying deformation that can exceed 3-4 metres.

[0007] During the impact the vehicle can tend to wedge between two adjacent metal cables (104) of the plurality of metal cables (104) which are thus forced to distance from one another. This has the effect that the two poles (102) knocked down, between which the vehicle is interposed, are forced to distance from one another and from the vehicle itself, sliding along the metal cables (104) with which it is engaged, which facilitates a further distancing of the adjacent metal cables (104) which can be such that the vehicle passes beyond the road safety barrier (100), with a serious risk to the safety of the occupants of the vehicles.

SUMMARY OF THE INVENTION

[0008] In the light of the above, the aim of the present invention consists in obviating the above-mentioned drawbacks.

[0009] The above-mentioned aim has been obtained by a road safety barrier with metal cables according to claim 1.

[0010] In accordance with claim 1, each metal cable of the plurality of metal cables winds about the lateral surface of a pole of the plurality of poles. In the case of impacts of a vehicle against the road safety barrier, in the impact zone the portions of metal cables interposed between a pole and another; even in a case in which the poles are knocked down, they enter into traction, gripping the poles about which they are wound, and preventing any sliding of the metal cables along the poles of the plurality of poles, or vice versa. Thus, beyond the impact zone the cables are not subject to any traction and therefore they do not lengthen. As the metal cables can deform, and therefore lengthen, only in the impact zone (having an extension of much less that the whole length of the metal cables, for example hundreds of metres) it follows that the overall lengthening of the metal cables can be less by even two orders of magnitude (i.e. less than 1%) with respect to the length that would result from using a road safety barrier of known type: this advantageously prevents the adjacent metal cables of the plurality of metal cables from distancing from one another. Thus, a vehicle which were to wedge between the adjacent metal cables would not be able to distance from them and pass beyond the road safety barrier.

[0011] A further advantage is that the bend that is created in the impact zone has a bellying deformation that is smaller than that which would ensue with a road safety barrier of known type, which enables installing the road safety barrier even in zones where there is not much free space available at the sides of the carriageway.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] Specific embodiments of the invention will be

described in the following part of the present description, according to what is set down in the claims and with the aid of the accompanying tables of drawings, in which:

- figure 1 is a perspective view of a portion of road safety barrier of known type;
- figure. 2 illustrates detail J of figure 1 in larger scale;
- figure 3 is a perspective view of a portion of road safety barrier according to the first embodiment of the invention;
- figure. 4 illustrates detail W of figure 3 in larger scale and in a lateral view;
- figure 5 is a perspective view of a portion of road safety barrier according to a second embodiment of the invention;
- figure 6 is a lateral view of the portion of road safety barrier of figure 5;
- figure 7 is a view of section VII-VII of figure 6;
- figure. 8 illustrates detail Z of figure 7 in larger scale;
- figure 9 is a perspective view of a portion of road safety barrier according to a further embodiment of the invention;
- figure. 10 illustrates detail V of figure 9 in larger scale.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] With reference to figures 3-10, reference numeral (1) is used to denote in its entirety a road safety barrier with metal cables, arranged along the side of a carriageway, for re-directing a vehicle in a case of impact, object of a first invention.

[0014] The road safety barrier (1) with a plurality of metal cables (4) comprises: a plurality of poles (2) which are fixed to the ground (3), which are distanced from one another and which are arranged one following another along the side of a carriageway (not illustrated); a plurality of metal cables (4) which are supported by the poles (2) of the plurality of poles (2), so that each metal cable (4) of the plurality of metal cables (4) is parallel to and at a predefined distance from the remaining metal cables (4) of the plurality of metal cables (4) in order to redirect a vehicle in a case of impact. Each metal cable (4) of the plurality of metal cables (4) is fixed to each pole (2) of the plurality of poles (2), and is wound at least once about the lateral surface (12) of the pole (2).

[0015] The metal cables (4) of the plurality of metal cables (4) are preferably arranged so as to contact the vehicle in the case of impact.

[0016] Figures 3, 4 illustrate a first embodiment of the invention.

[0017] The metal cables (4) of the plurality of metal cables (4) are preferably at least three in number: in figures 3-10, for example, they are four in number.

[0018] Further, the metal cables (4) of the plurality of metal cables (4) are preferably made of steel.

[0019] The poles (2) of the plurality of poles (2) are preferably made of metal, for example, steel.

[0020] In a second embodiment of the invention, see for example figures 5-8, the road safety barrier (1) further comprises: a plurality of slab-shaped elements (7), each of which is supported by at least two metal cables (4) of the plurality of metal cables (4). The slab-shaped elements (7) of the plurality of slab-shaped elements (7) are connected to the metal cables (4) of the plurality of metal cables (4) in such a way as to maintain each metal cable (4) of the plurality of metal cables (4) parallel to and at a predefined distance from the remaining metal cables (4) of the plurality of metal cables (4).

[0021] The slab-shaped elements (7) advantageously constitute a further constraint for maintaining each metal cable (4) of the plurality of metal cables (4) parallel to and at a predefined distance from the remaining metal cables (4) of the plurality of metal cables, so that there are still greater probabilities that a vehicle which were to wedge between the adjacent metal cables (4) of the plurality of metal cables (4) would not be able to distance from them and pass beyond the road safety barrier (1).

[0022] Further, where the space between the adjacent metal cables (4) of the plurality of metal cables (4) is occupied by the slab-shaped elements (7) of the plurality of slab-shaped elements (7), the risk that a vehicle might also only wedge in this space is also eliminated.

[0023] In the example illustrated in figures 5, 6, all the spaces between the adjacent metal cables (4) are advantageously occupied by the slab-shaped elements (7) of the plurality of slab-shaped elements (7).

[0024] The slab-shaped elements (7) of the plurality of slab-shaped elements (7) are made of a transparent material, so as to limit the environmental impact.

[0025] The slab-shaped elements (7) of the plurality of slab-shaped elements (7) are preferably made of polycarbonate and glass, so that they are transparent and therefore have a low environmental impact, but at the same time they can have high resistance to impact and scratching as well as a high degree of durability.

[0026] Each slab-shaped element (7) of the plurality of slab-shaped elements (7) can be connected to all the cables (4) of the plurality of cables (4), as shown in figures 5, 6 and 7.

[0027] Each slab-shaped element (7) of the plurality of slab-shaped elements (7) preferably comprises at least two housings (9), each of which is conformed so as to be crossable by a metal cable (4) of the plurality of metal cables (4), so that each slab-shaped element (7) of the plurality of slab-shaped elements (7) is slidably supported by the at least two metal cables (4) of the plurality of metal cables (4) which cross the at least two housings (9).

[0028] In the case of an impact, the portions of metal cables (4) of the plurality of metal cables (4) between two successive poles (2) of the plurality of poles (2), set in traction by the impact itself, deform across the at least two housings (9) of each slab-shaped element (7) of the plurality of slab-shaped elements (7). The possibility of relative movement between said metal cables (4) and said slab-shaped elements (7) is advantageously such that the metal cables (4) can absorb the stresses asso-

ciated to the impact by deforming without transmitting the stresses to the slab-shaped elements (7) which, not being provided with a deformability comparable to that of the metal cables (4), would not be able to absorb them.

[0029] The at least two housings (9) can comprise through-holes or hooks, as illustrated in figure 8, to enable the sliding of the metal cables (4).

[0030] Each slab-shaped element (7) of the plurality of slab-shaped elements (7) preferably comprises a number of housings (9) equal to the number of metal cables (4) of the plurality of metal cables (4).

[0031] Each slab-shaped element (7) of the plurality of slab-shaped elements (7) can also be arranged in such a way as to be connected to one or all the poles (2) of the plurality of poles (2), see in particular figures 5 and 6.

[0032] The slab-shaped elements (7) of the plurality of slab-shaped elements (7) are preferably interposed between the metal cables (4) of the plurality of metal cables (4) and the carriageway.

[0033] This arrangement guarantees that in a case of impact the impacting vehicle comes into contact with one or more slab-shaped elements (7) of the plurality of slab-shaped elements (7) and not with the plurality of metal cables (4). The slab-shaped elements (7) advantageously dampen the impact and thus limit the risk that the impacting vehicle is cut by the metal cables (4) set in traction following the impact. Further, the possibility that a vehicle can wedge between two adjacent metal cables (4) of the plurality of metal cables (4) is reduced. This further improves the performance of the road safety barrier (1) in terms of safety for the occupants of the impacting vehicle.

[0034] This advantage is particularly important in a case in which the impact involves the more vulnerable road users, i.e. cyclists and motor cyclists, for whom the direct contact with the metal cables (4) of the plurality of metal cables (4), during the impact step, might in all probability be fatal.

[0035] In both embodiments of the first invention, each pole (2) of the plurality of poles (2) can preferably have a circular section, see from figures 3 to 8.

[0036] The circular shape of the section advantageously facilitates the winding of each metal cable (4) of the plurality of metal cables (4) about the lateral surface (12) of each pole (2) of the plurality of poles (2).

[0037] The ratio between a diameter of each metal cable (4) of the plurality of metal cables (4) and a diameter of a circumference defined by the circular section (10) is preferably less than or equal to 0.2.

[0038] This advantageously enables each metal cable (4) of the plurality of metal cables (4) to be wound around each pole (2) of the plurality of poles (2), guaranteeing contact with the lateral surface (12) of the pole (2) along the entire extension of the winding.

[0039] Alternatively, in both embodiments of the first invention, described in the foregoing, each pole (2) of the plurality of poles (2) can have a polygonal section, see in particular figures 9 and 10.

[0040] By polygonal section is meant, for example, a quadrilateral section, see figures 9 and 10,or a pentagonal, hexagonal, octagonal, trapezoidal section (not illustrated).

[0041] In the case of a polygonal pole (2), the pole (2) of the plurality of poles (2) is preferably conformed so as to be without live edges at least at relative portions of lateral surface (12) about which the metal cables (4) of the plurality of metal cables (4) are wound.

[0042] The risk that the metal cable (4) of the plurality of metal cables (4), which winds about each pole (2) of the plurality of poles (2), will be damaged at the live edges of the pole (2) is advantageously minimised.

[0043] The ratio between a diameter of each metal cable (4) of the plurality of metal cables (4) and a diameter of a circumference inscribed in the polygonal section of each pole (2) of the plurality of poles (2) is preferably less than or equal to 0.2.

[0044] In this way it is advantageously possible to wind the metal cable (4) about each pole (2), thus guaranteeing contact of the metal cable (4) with the lateral surface (12) of the pole (2) along the whole extension of the winding.

Claims

1. A road safety barrier (1) with a plurality of metal cables (4), arranged along the side of a carriageway, for re-directing a vehicle in a case of impact, comprising:

   a plurality of poles (2) which are fixed to the ground (3), which are distanced from one another and which are arranged one following another along the side of a carriageway;
   a plurality of metal cables (4) which are supported by the poles (2) of the plurality of poles (2), so that each metal cable (5) of the plurality of metal cables (4) is parallel to and at a predefined distance from the remaining metal cables (4) of the plurality of metal cables (4) in order to redirect a vehicle in a case of impact;
   characterised in that:
   each metal cable (5) of the plurality of metal cables (4) is fixed to each pole (2) of the plurality of poles (2), and is wound at least once about the lateral surface (12) of the pole (2).

2. The road safety barrier (1) of claim 1, wherein the metal cables (4) of the plurality of metal cables (4) are arranged so as to contact the vehicle in a case of impact.

3. The road safety barrier (1) of any one of the preceding claims, comprising a plurality of slab-shaped elements (7), each of which is supported by at least two metal cables (4) of the plurality of metal cables (4);

the slab-shaped elements (7) of the plurality of slab-shaped elements (7) being connected to the metal cables (4) of the plurality of metal cables (4) in such a way as to maintain each metal cable (4) of the plurality of metal cables (4) parallel to and at a predefined distance from the remaining metal cables (4) of the plurality of metal cables (4).

4. The road safety barrier (1) of the preceding claim, wherein each slab-shaped element (7) of the plurality of slab-shaped elements (7) comprises at least two housings (9), each of which is conformed so as to be crossable by a metal cable (4) of the plurality of metal cables (4), so that each slab-shaped element (7) of the plurality of slab-shaped elements (7) is slidably borne by the at least two metal cables (4) of the plurality of metal cables (4) which cross the at least two housings (9).

5. The road safety barrier (1) of claim 3 or 4, wherein the slab-shaped elements (7) of the plurality of slab-shaped elements (7) are interposed between the metal cables (4) of the plurality of metal cables (4) and the carriageway.

6. The road safety barrier (1) of any one of the preceding claims, wherein each pole (2) of the plurality of poles (2) has a circular section.

7. The road safety barrier (1) of the preceding claim, wherein a ratio between a diameter of each metal cable (4) of the plurality of metal cables (4) and a diameter of a circumference defined by the circular section is less than or equal to 0.2.

8. The road safety barrier (1) of any one of the preceding claims from 1 to 5, wherein each pole (2) of the plurality of poles (2) has a polygonal section.

9. The road safety barrier (1) of the preceding claim, wherein each pole (2) of the plurality of poles (2) is conformed so as to be without live edges at least at relative portions of lateral surface (12) about which the metal cables (4) of the plurality of metal cables (4) are wound.

10. The road safety barrier (1) of claim 8 or 9, wherein a ratio between a diameter of each metal cable (4) of the plurality of metal cables (4) and a diameter of a circumference inscribed in the polygonal section of each pole (2) of the plurality of poles (2) is less than or equal to 0.2.

Patentansprüche

1. Straßenschutzbarriere (1) mit einer Vielzahl von Drahtseilen (4), die entlang der Seite einer Fahrbahn angeordnet ist, um ein Fahrzeug im Falle eines Aufpralls umzulenken, umfassen:

eine Vielzahl von Pfosten (2), die am Boden (3) befestigt sind, die voneinander beabstandet sind und die aufeinanderfolgend entlang der Seite einer Fahrbahn angeordnet sind;
eine Vielzahl von Drahtseilen (4), die von den Pfosten (2) der Vielzahl von Pfosten (2) getragen werden, so dass jedes Drahtseil (4) der Vielzahl von Drahtseilen (4) parallel zu den und in einem vorbestimmten Abstand von den übrigen Drahtseilen (4) der Vielzahl von Drahtseilen (4) angeordnet ist, um ein Fahrzeug im Falle eines Aufpralls umzulenken;
dadurch gekennzeichnet, dass:
jedes Drahtseil (4) der Vielzahl von Drahtseilen (4) an jedem Pfosten (2) der Vielzahl von Pfosten (2) befestigt ist und zumindest einmal um die seitliche Oberfläche (12) des Pfostens (2) gewickelt ist.

2. Straßenschutzbarriere (1) nach Anspruch 1, wobei die Drahtseile (4) der Vielzahl von Drahtseilen (4) derart angeordnet sind, dass sie das Fahrzeug im Falle eines Aufpralls berühren.

3. Straßenschutzbarriere (1) nach einem der vorhergehenden Ansprüche, umfassend eine Vielzahl von plattenförmigen Elementen (7), von denen jedes von zumindest zwei Drahtseilen (4) der Vielzahl von Drahtseilen (4) getragen wird;
wobei die plattenförmigen Elemente (7) der Vielzahl von plattenförmigen Elementen (7) mit den Drahtseilen (4) der Vielzahl von Drahtseilen (4) derart verbunden sind, dass sie jedes Drahtseil (4) der Vielzahl von Drahtseilen (4) parallel zu und in einem vorbestimmten Abstand von den übrigen Drahtseilen (4) der Vielzahl von Drahtseilen (4) halten.

4. Straßenschutzbarriere (1) nach dem vorhergehenden Anspruch, wobei jedes plattenförmige Element (7) der Vielzahl von plattenförmigen Elementen (7) zumindest zwei Aufnahmen (9) umfasst, die jeweils so beschaffen sind, dass ein Drahtseil (4) der Vielzahl von Drahtseilen (4) durch sie hindurch geführt werden kann, so dass jedes plattenförmige Element (7) der Vielzahl von plattenförmigen Elementen (7) gleitbar von den zumindest zwei Drahtseilen (4) der Vielzahl von Drahtseilen (4) getragen wird, die durch die zumindest zwei Aufnahmen (9) geführt sind.

5. Straßenschutzbarriere (1) nach Anspruch 3 oder 4, wobei die plattenförmigen Elemente (7) der Vielzahl von plattenförmigen Elementen (7) zwischen den Drahtseilen (4) der Vielzahl von Drahtseilen (4) und der Fahrbahn angeordnet sind.

6. Straßenschutzbarriere (1) nach einem der vorhergehenden Ansprüche, wobei jeder Pfosten (2) der Vielzahl von Pfosten (2) einen kreisförmigen Querschnitt aufweist.

7. Straßenschutzbarriere (1) nach dem vorhergehenden Anspruch, wobei ein Verhältnis zwischen einem Durchmesser jedes Drahtseils (4) der Vielzahl von Drahtseilen (4) und einem Durchmesser eines durch den kreisförmigen Querschnitt definierten Umfangs kleiner oder gleich 0,2 ist.

8. Straßenschutzbarriere (1) nach einem der vorhergehenden Ansprüche von 1 bis 5, wobei jeder Pfosten (2) der Vielzahl von Pfosten (2) einen polygonalen Querschnitt aufweist.

9. Straßenschutzbarriere (1) nach dem vorhergehenden Anspruch, wobei jeder Pfosten (2) der Vielzahl von Pfosten (2) so beschaffen ist, dass er keine scharfen Kanten aufweist, zumindest an entsprechenden Abschnitten der seitliche Oberfläche (12), um welche die Drahtseile (4) der Vielzahl von Drahtseilen (4) gewickelt sind.

10. Straßenschutzbarriere (1) nach Anspruch 8 oder 9, wobei ein Verhältnis zwischen einem Durchmesser jedes Drahtseils (4) der Vielzahl von Drahtseilen (4) und einem Durchmesser eines im polygonalen Querschnitt jedes Pfostens (2) der Vielzahl von Pfosten (2) einbeschriebener Umfang kleiner oder gleich 0,2 ist.

Revendications

1. Une barrière de sécurité routière (1) avec une pluralité de câbles métalliques (4), disposée le long du côté d'une chaussée, pour rediriger un véhicule en cas d'impact, comprenant :

une pluralité de poteaux (1) qui sont fixés au sol (3), qui sont espacés les uns des autres et qui sont disposés les uns après les autres le long du côté d'une chaussée ;
une pluralité de câbles métalliques (4) qui sont supportés par les poteaux (2) de la pluralité de poteaux (2), de manière à ce que chaque câble métallique (4) de la pluralité de câbles métalliques (4) soit parallèle à et à une distance prédéfinie des câbles métalliques restants (4) de la pluralité de câbles métalliques (4) afin de rediriger un véhicule en cas d'impact ;
caractérisée en ce que :
chaque câble métallique (4) de la pluralité de câbles métalliques (4) est fixé à chaque poteau (2) de la pluralité de poteaux (2), et est enroulé au moins une fois autour de la surface latérale (12) du poteau (2).

2. La barrière de sécurité routière (1) selon la revendication 1, dans laquelle les câbles métalliques (4) de la pluralité de câbles métalliques (4) sont disposés de manière à venir en contact avec le véhicule en cas d'impact.

3. La barrière de sécurité routière (1) selon l'une quelconque des revendications précédentes, comprenant une pluralité d'éléments en forme de plaque (7), dont chacun est supporté par au moins deux câbles métalliques (4) de la pluralité de câbles métalliques (4) ;
les éléments en forme de plaque (7) de la pluralité d'éléments en forme de plaque (7) étant raccordés aux câbles métalliques (4) de la pluralité de câbles métalliques (4) de manière à maintenir chaque câble métallique (4) de la pluralité de câbles métalliques (4) parallèle à et à une distance prédéfinie des câbles métalliques restants (4) de la pluralité de câbles métalliques (4).

4. La barrière de sécurité routière (1) selon la revendication précédente, dans laquelle chaque élément en forme de plaque (7) de la pluralité d'éléments en forme de plaque (7) comprend au moins deux logements (9), dont chacun est conformé de manière à pouvoir être traversé par un câble métallique (4) de la pluralité de câbles métalliques (4), afin que chaque élément en forme de plaque (7) de la pluralité d'éléments en forme de plaque (7) soit porté de façon coulissante par lesdits au moins deux câbles métalliques (4) de la pluralité de câbles métalliques (4) qui traversent lesdits au moins deux logements (9).

5. La barrière de sécurité routière (1) selon la revendication 3 ou 4, dans laquelle les éléments en forme de plaque (7) de la pluralité d'éléments en forme de plaque (7) sont interposés entre les câbles métalliques (4) de la pluralité de câbles métalliques (4) et la chaussée.

6. La barrière de sécurité routière (1) selon l'une quelconque des revendications précédentes, dans laquelle chaque poteau (2) de la pluralité de poteaux (2) a une section circulaire.

7. La barrière de sécurité routière (1) selon la revendication précédente, dans laquelle un rapport entre un diamètre de chaque câble métallique (4) de la pluralité de câbles métalliques (4) et un diamètre d'une circonférence définie par la section circulaire est inférieur ou égal à 0,2.

8. La barrière de sécurité routière (1) selon l'une quelconque des revendications précédentes de 1 à 5, dans laquelle chaque poteau (2) de la pluralité de

poteaux (2) a une section polygonale.

9. La barrière de sécurité routière (1) selon la revendication précédente, dans laquelle chaque poteau (2) de la pluralité de poteaux (2) est conformé de manière à être privé d'arêtes vives au moins au niveau de portions correspondantes de surface latérale (12) autour desquelles les câbles métalliques (4) de la pluralité de câbles métalliques (4) sont enroulés.

10. La barrière de sécurité routière (1) selon la revendication 8 ou 9, dans laquelle un rapport entre un diamètre de chaque câble métallique (4) de la pluralité de câbles métalliques (4) et un diamètre d'une circonférence inscrite dans la section polygonale de chaque poteau (2) de la pluralité de poteaux (2) est inférieur ou égal à 0,2.

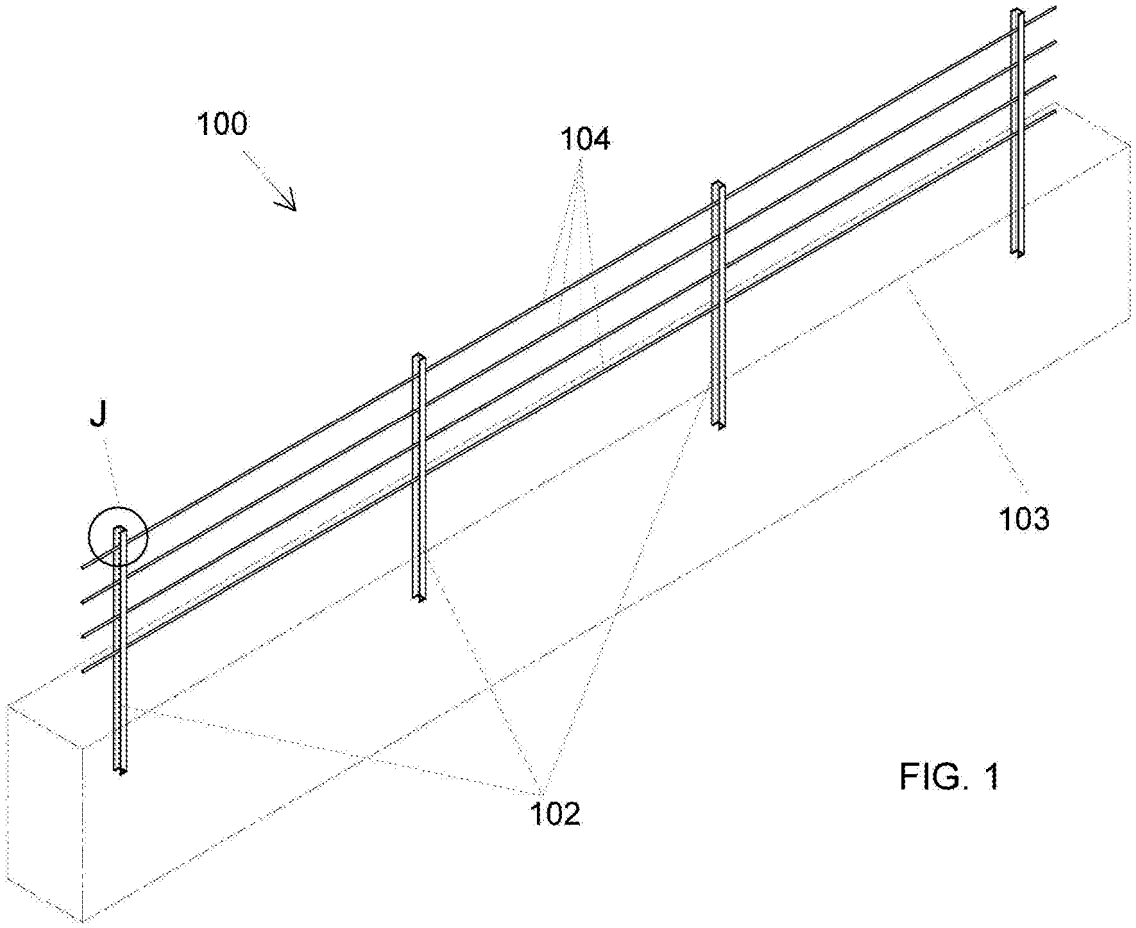


FIG. 1

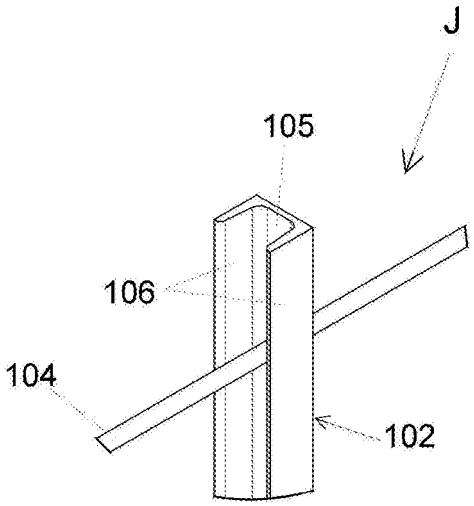


FIG. 2

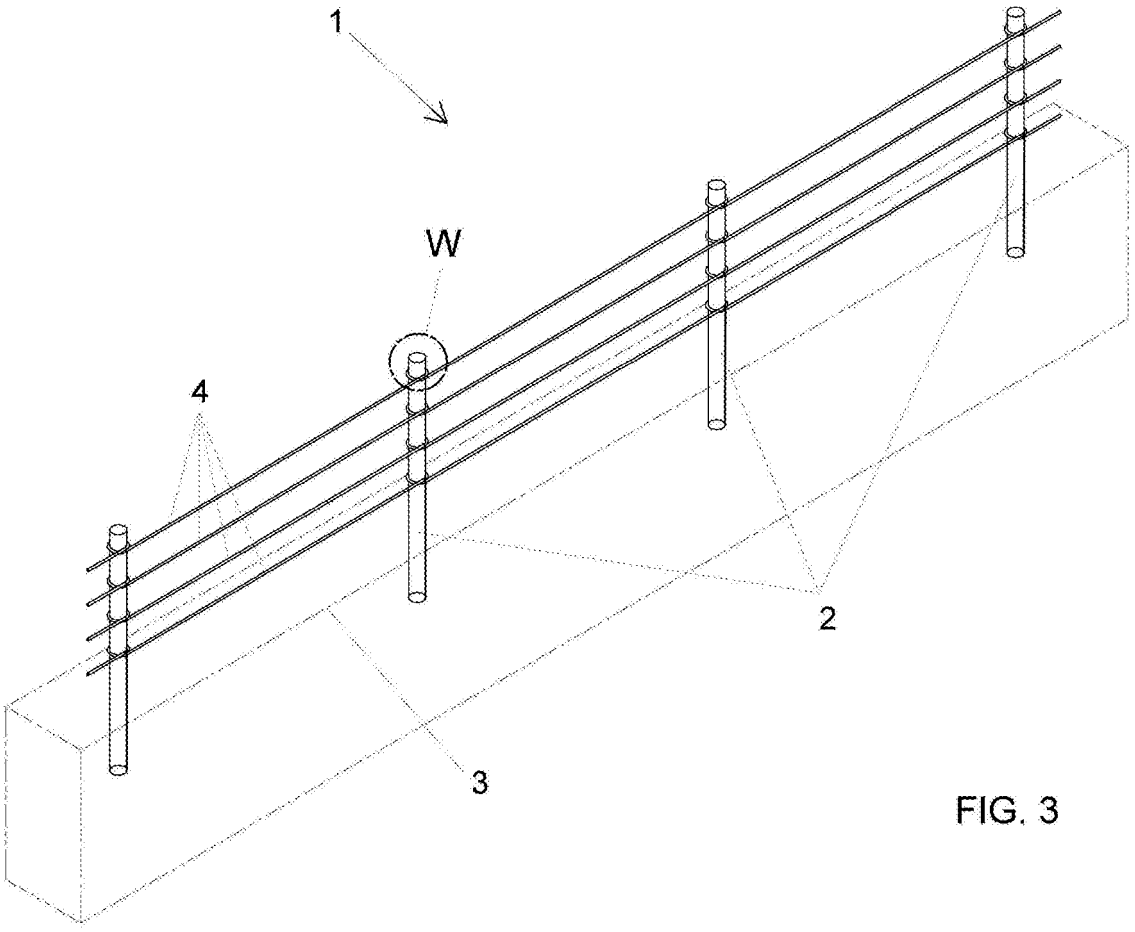


FIG. 3

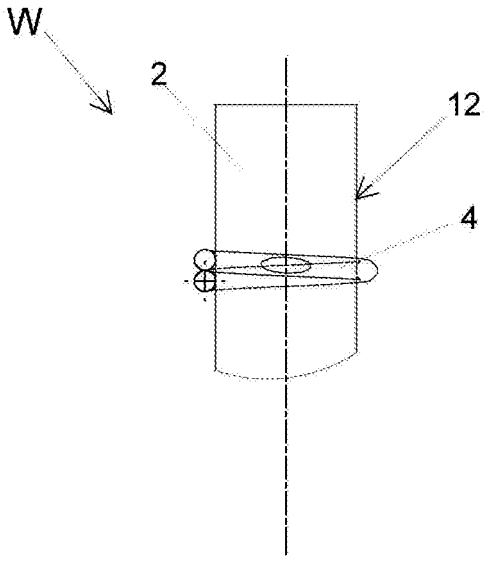


FIG. 4

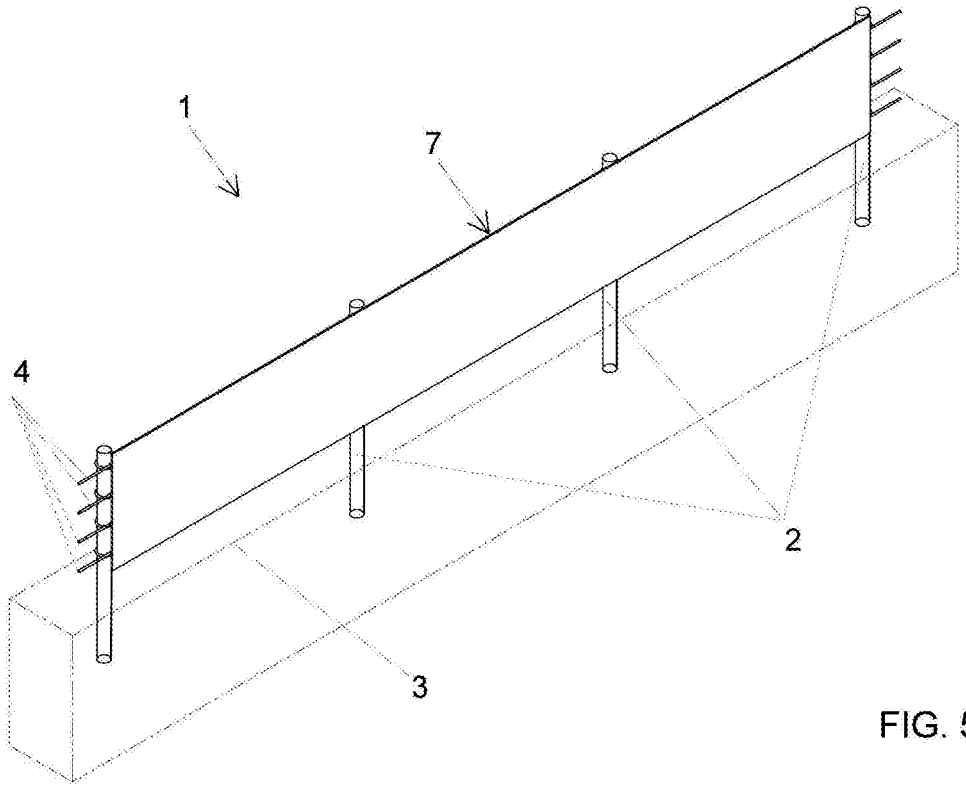


FIG. 5

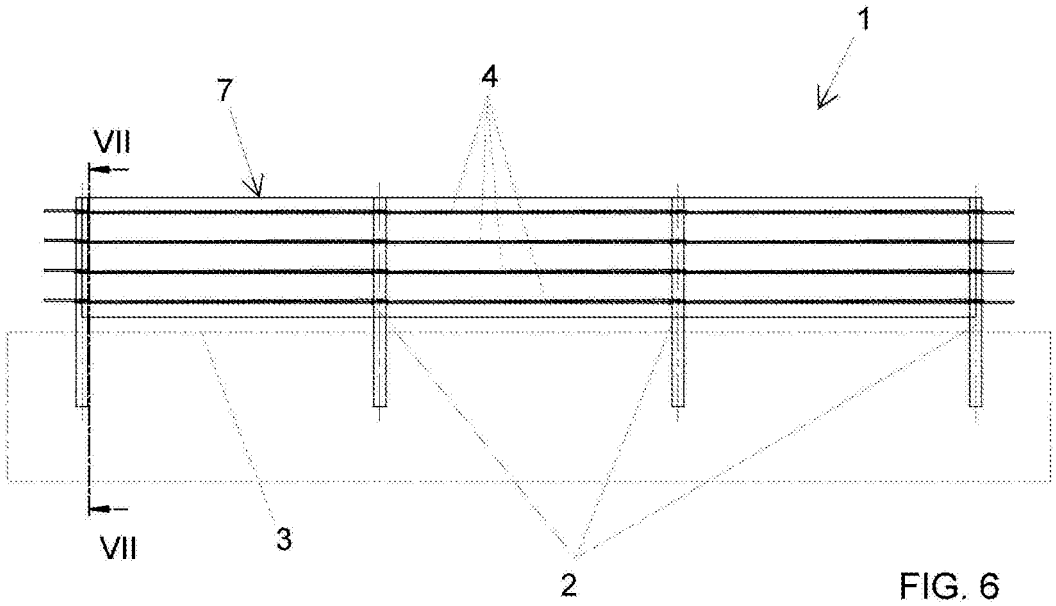


FIG. 6

FIG. 7

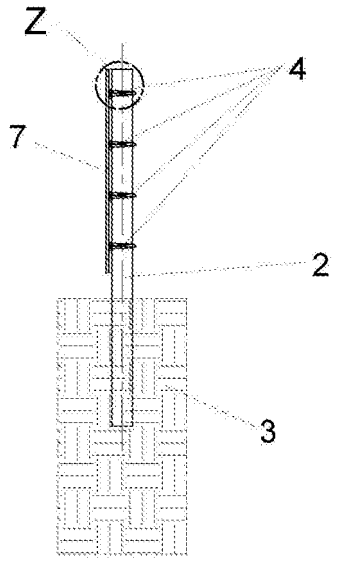
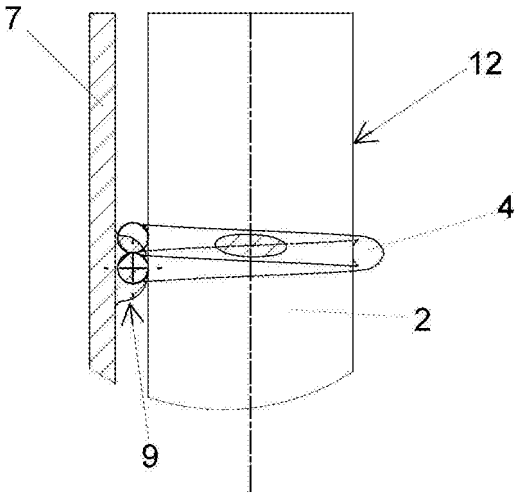


FIG. 8



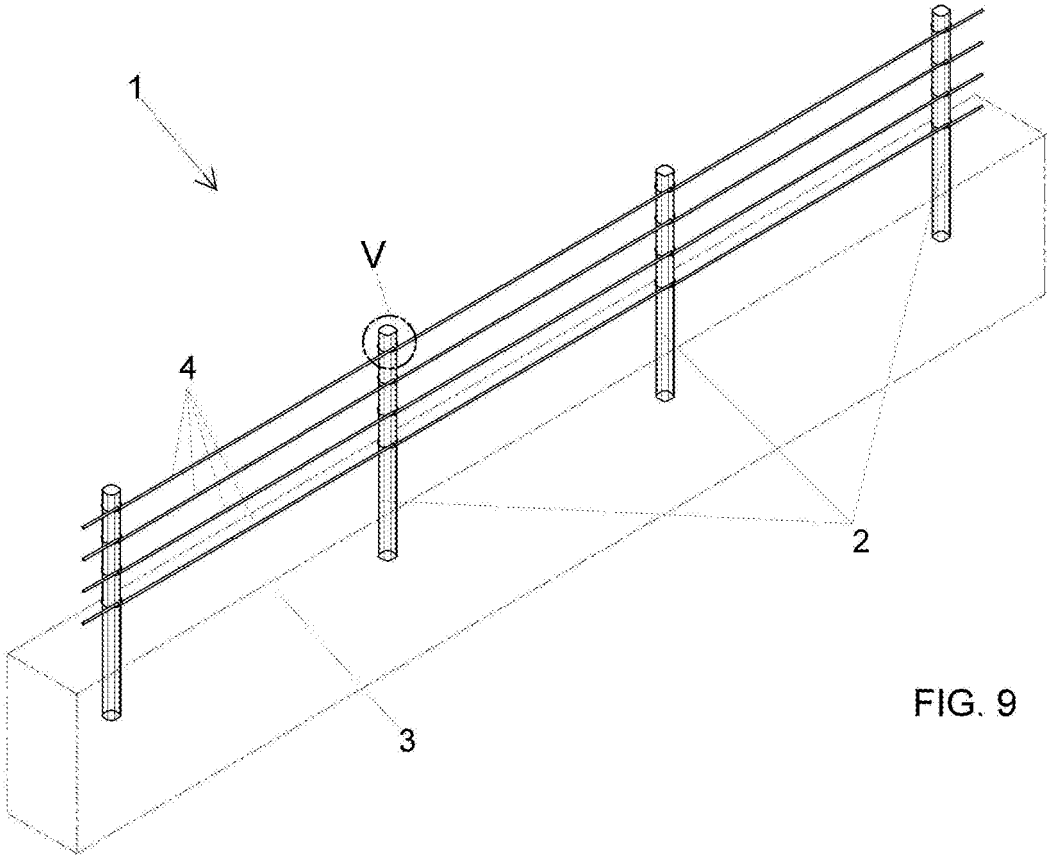


FIG. 9

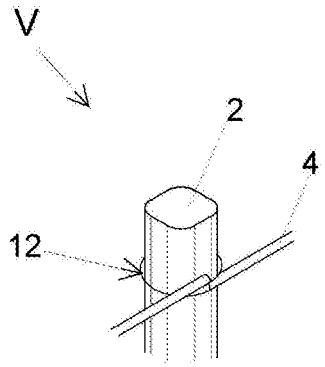


FIG. 10

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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