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(54) **SAFETY PROTECTION APPARATUS OF ELASTIC-PLASTIC STEEL STRUCTURE**

(57) A safety protection apparatus of elastic-plastic steel structure is disclosed. The apparatus includes an outer protecting layer (4) and buffering assemblies arranged in a layered manner along the vertical direction and fixed within the outer protecting layer (4). Each buffering assembly includes stiffening beams (3) distributed in a layered manner along the horizontal direction and buffer members (2) uniformly bridging between adjacent stiffening beams (3), and each of said buffer members (2) comprises a pair of arc-shaped damping spokes (1). Shock absorbing rubber elements (5) are provided between vertically adjacent stiffening beams (3). The apparatus has high safety, good durability, and it is convenient to be installed and maintained.

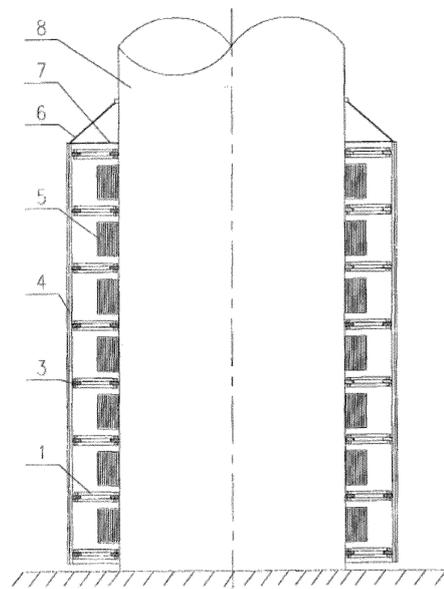


Fig. 2

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Description

Technical Field

[0001] The invention relates to the technical field of structure protection in the operation of bridges and buildings, and more specifically relates to a safety protection apparatus, in particular a safety protection apparatus of elastic-plastic steel structure.

Technical Background

[0002] Traffic safety is not satisfactory in China for a long time. On numerous critical structures that may affect the public transportation safety, no protection apparatuses for isolating or mitigating the impacts of vehicles, such as cars or ships, are provided, which directly threatens the safety of lives and properties. However, as the traffic volume in China increases rapidly, the contradictions between cars or ships and the surrounding buildings near roads or rivers become more and more significant. Accidents of cars or ships crashing into bridge piers or surrounding buildings happen at times, resulting in collapse of bridge piers or building structures, destroy of cars or ships and casualty of human in serious cases. The reason is supposed to be that the direct impact between cars or ships and the surrounding structures is a rigid collision, during which extremely serious injuries will occur since no energy releasing or isolating devices are provided.

[0003] In order to solve such problems, some protection measures such as increasing the structural sizes of bridge piers or adopting simple protection devices, e.g., steel tube fences or bumper piles, have already been used, which to some extent ensure the structural safety of bridge piers. However, such devices are far from satisfying in respect of aesthetics and practical applicability. And above all, since the impact between cars or ships and the protection devices is still rigid collision, it is not possible to alleviate the harm towards the vehicles or humans from the impact without effective release of the energy.

Summary Of The Invention

[0004] An object of the present invention is to provide a safety protection apparatus of elastic-plastic steel structure with high-efficient energy releasing ability in order to solve the problems existing in the prior arts, e.g., the energy of collision cannot be released effectively when rigid impacts occur between cars or ships and important surrounding building structures or bridge piers so that it is unable to alleviate the harm from the impacts towards vehicles or humans.

[0005] In order to solve the problems existing in the prior arts, the present invention provides a safety protection apparatus of elastic-plastic steel structure, including an outer protecting layer and buffering assemblies arranged in a layered manner along the vertical direction

and fixed within the outer protecting layer, wherein each buffering assembly includes stiffening beams distributed in a layered manner along the horizontal direction and buffer members uniformly bridging between adjacent stiffening beams,

each of said buffer members comprises a pair of arc-shaped damping spokes fastened to each other, one end of one of the damping spokes is crossed with one end of the other damping spoke;

said buffer members of adjacent buffering assemblies are arranged in a stagger manner with each other along the vertical direction, and

shock absorbing rubber elements are provided between vertically adjacent stiffening beams, wherein vertically adjacent shock absorbing rubber elements are arranged in a stagger manner with each other.

[0006] The crossed ends of said pair of damping spokes are connected with outer horizontal stiffening beam, while the other ends are connected with adjacent inner horizontal stiffening beam.

[0007] Said buffer members are provided on both the upper side and the lower side of said stiffening beams, and the buffer members on the upper side are arranged in a stagger manner along the vertical direction relative to those on the lower side.

[0008] A dustproof cover board is provided on the top of said outer protecting layer.

[0009] Suspended draglines are provided on the outer horizontal stiffening beam of the top buffering assembly.

[0010] Said damping spoke is made from elastic-plastic mild steel, and has a longitudinal cross section of C shape, semi-ellipse shape, nonlinear arc shape or the like.

[0011] Said stiffening beam is connected with the damping spoke via pins or rivets.

[0012] Said outer protecting layer is made by high-ductile steel plate with vulcanized rubber thereon, and the transverse cross section of the outer protecting layer is of a closed shape or a linear shape.

[0013] Compared with the prior arts, the present invention possesses the following advantages and technical effects.

1. Compared with conventional collision-prevention devices, the safety protection apparatus according to the present invention provides a flexible outer protecting layer, damping spokes and shock absorbing rubber elements as energy releasing materials for collision, which, through connection with annular stiffening beams one of which being nested into the other, forms an elastic-plastic energy releasing apparatus with a high integrity. When it is hit by a car or a ship, the safety protection apparatus can prolong the duration of collision, release the energy from the collision and reduce the impact force via the elastic-plastic deformation of the damping spokes. Due to the integral effectiveness of the outer protecting layer and the stiffening beams, more damping spokes will

be subjected to the impact force, in particular in the case of side collision. Therefore, the force can be transmitted farther, thus increasing the area for receiving the impact force, dispersing the impact force and achieving a more uniform stress condition.

2. The present invention provides a multilevel protection, which includes a three-level energy releasing protection structure with a light collision protection level, an intermediate collision protection level and a strong collision protection level. In the case of the light collision, the outer protecting layer and the damping spokes of the safety protection apparatus function together to generate a deformation which will consume energy, but the elastic-plastic steel is substantially in a stage of elastic deformation or only generates a relatively low plastic deformation. In the case of the intermediate collision, the outer protecting layer and the steel damping spokes of the safety protection apparatus function together to generate a deformation which consumes energy, wherein the damping spokes are deformed plastically to a relatively large extent. However, the displacement caused by the collision is still less than the gap between the outer stiffening beams and the shock absorbing rubber elements. Consequently, the outer stiffening beams cannot contact with the shock absorbing rubber elements. In the case of the strong collision, the safety protection apparatus generates a large displacement, enabling the outer stiffening beams to contact the shock absorbing rubber elements. In this case, the safety protection apparatus can release energy through the deformation of the outer protecting layer and the stiffening beams, the plastic deformation of the damping spokes, and the compressing deformation of the shock absorbing rubber elements all together. In this way, the duration of collision is effectively prolonged, and the impact force is lowered significantly. Although the damping spokes generate a large plastic deformation, the displacement limit of the structural design would not be exceeded due to the shock absorbing rubber elements provided to achieve a final limit protection and energy releasing function. Therefore, no breakdown of the damping spokes will happen, and thus the integral function of buffering collision of the safety protection apparatus is ensured. In addition, the impact force can be applied to the bridge piers more uniformly due to the existence of the shock absorbing rubber elements, and the bridge piers are better protected.

3. In the case of a side collision, the outer stiffening beam and the elastic-plastic steel can rotate to a certain extent during the collision due to the pin joint between the elastic-plastic steel and the outer stiffening beam, so that the impact point of the cars or ships will change, with the result that most of the

kinetic energy of the cars or ships will be retained on the cars or ships, keeping the cars and ships away from the bridge piers or the building structures without being stuck. In this way, the energy exchange during the collision of cars or ships with the bridge piers or the building structures is considerably reduced, thus protecting the bridge piers or building structure.

4. The upper and lower layers of the damping spokes are arranged in a stagger way with each other and connected to the stiffening beams in a symmetrical structure. Therefore, the stress condition in collisions from different directions is also symmetrical. Thus the protection effect in the case of collisions from various directions can be ensured.

5. In the safety protection apparatus according to the invention, the bottom is separated from the ground. In order to support the safety protection apparatus along the vertical direction, the safety protection apparatus is provided with suspended draglines on the top thereof. The draglines can restrict the deformation of the outer stiffening beams of the safety protection apparatus along the vertical direction, thus mitigating the effect of collision. Compared with the design of connecting the bottom of the safety protection apparatus to the ground, wherein wastes will easily accumulate at the bottom of the protection apparatus and thus influence on cleaning and the effect of slipping of the safety protection apparatus after being subjected to the impact force, the design of adopting suspended draglines is especially advantageous for the deformation and maintenance of the safety protection apparatus.

6. The inner stiffening beam of the safety protection apparatus according to the invention is mounted to surround the bridge piers or the building structures with no damages being generated thereto. Therefore, the safety protection apparatus can be used in a variety of applications. The stiffening beams, the steel damping spokes and the shock absorbing rubber elements of the safety protection apparatus are all designed as modular units, and are connected via pins and rivets, thus achieving an easier mount, maintenance and replacement. Since only the damaged elements in some particular locations are required to be replaced after a strong collision, the cost of repair and maintenance is low.

Brief Description Of The Drawings

[0014]

Figure 1 shows schematically the top view of a structure of the elastic-plastic steel damping spoke according to the invention.

Figure 2 shows the front view of the structure of the one-layer safety protection apparatus of Example 1.

Figures 3, 4 and 5 show top views of the structure of the one-layer safety protection apparatus of Example 1.

Figure 6 shows the front view of a structure of the multiple-layer safety protection apparatus of Example 2.

Figure 7 shows the top view of the structure of the multiple-layer safety protection apparatus of Example 2.

Figures 8, 9 and 10 show top views of a structure of the interchange triangular area with the safety protection apparatus of Example 3, wherein Figure 8 shows the rear part of the interchange triangular area, Figure 9 shows the front part of the interchange triangular area, and Figure 10 schematically shows the guiding lines of the interchange triangular area.

Figure 11 shows the front view of a structure of the draglines and the cover board of the safety protection apparatus of Example 4.

Figure 12 shows the top view of the structure of the dragline and the cover board of the safety protection apparatus of Example 4.

Detailed Description Of The Embodiments

[0015] The invention will be discussed in detail with reference to the attached drawings and examples below.

[0016] Figures 1, 2, and 3 show a safety protection apparatus of elastic-plastic steel structure, which includes an outer protecting layer 4 and buffering assemblies arranged in a layered manner along the vertical direction and fixed within the outer protecting layer 4. Each buffering assembly includes stiffening beams 3 distributed in a layered manner along the horizontal direction, and buffer members 2 uniformly arranged and bridging between adjacent stiffening beams 3. The buffer members 2 are provided on both the upper side and the lower side of the stiffening beam 3, and the buffer member 2 on the upper side of the stiffening beam 3 is arranged in a stagger manner along the vertical direction relative that on the lower side of the stiffening beams 3. Each of the buffer members 2 is in the form of a pair of arc-shaped damping spokes 1 fastened to each other, and one end of one damping spoke 1 is crossed with one end of the other. The damping spoke 1 is made from elastic-plastic mild steel, and has a longitudinal cross section with C shape, semi-ellipse shape, nonlinear arc shape or the like. When there is a collision, the duration of collision can be prolonged, the energy from the collision can be released and the impact force can be reduced via the

plastic deformation of the damping spokes. Shock absorbing rubber elements 5 are provided between two vertically adjacent stiffening beams 3 of adjacent buffering assemblies. The shock absorbing rubber elements 5 are arranged between adjacent stiffening beams 3 and connected thereto, and snugly surround the bridge pier 8 or connect thereto via rivets. Vertically adjacent shock absorbing rubber elements 5 are arranged in a stagger manner with each other. Said outer protecting layer 4 is made by a high ductile steel plate with vulcanized rubber thereon. The horizontal cross section of the outer protecting layer 4 can be of a closed shape, such as an oval, a racetrack, a circle, a rectangle or other planar shapes, although it can also be a linear shape, such as a line, an arc. The shape of the horizontal cross section of the outer protecting layer 4 is similar with the profile of a bridge pier. A dustproof cover board 7, which can prevent dusts, rain or snow from entering into the protection apparatus, is provided on the top buffering assembly of the protecting outer layer 4. Suspended draglines 6 are provided on the outer horizontal stiffening beam 3 of the top buffering assembly. The protection apparatus can be suspended and connected to the upper part of the bridge pier 8 by the suspended draglines 6, so that slide and rotation of the safety protection apparatus are allowable.

[0017] During construction, according to the invention, the innermost stiffening beams 3 are used to embrace around the bridge pier 8 tightly via bolts. The elastic-plastic steel damping spokes 1 connect the inner stiffening beam 3 with the corresponding outer stiffening beam 3 into a whole body via connecting pins. The outermost stiffening beam 3 on the top layer is suspended and connected to the bridge pier 8 via the suspended draglines 6. The dustproof cover board 7 is finally arranged on top of the protecting outer layer 4.

Example 1

[0018] As is shown in Figures 2 and 3, in the outer protecting layer 4 of Example 1 eight buffering assemblies are arranged along the vertical direction surrounding the bridge pier 8. The horizontal cross section of the outer protecting layer 4 is circular. Each buffering assembly includes two stiffening beams 3 of annular shape, one horizontally nested within the other. Buffer members 2 are arranged uniformly on the upper side and the lower side of two stiffening beams 3 along the vertical direction. Adjacent buffer members 2 are arranged in a stagger manner, with the crossed end and the other end of each buffer member 2 being connected with the outer and inner horizontal stiffening beam 3 respectively. The inner horizontal stiffening beam 3 embraces the bridge pier 8 tightly. Shock absorbing rubber elements 5 are connected with two vertically adjacent inner stiffening beams 3, and surround the bridge pier 8 tightly via rivets. The outer horizontal stiffening beam 3 of each buffering assembly is fixed to the inner wall of the outer protecting layer 4. Suspended draglines 6 are provided on the outer hori-

zontal stiffening beam 3 of the top buffering assembly. The suspended draglines 6 are connected to the upper part of the bridge pier 8, and thus maintain the bottom buffering assembly separated from the ground. The dust-proof cover board 7 is arranged on the top of the outer protecting layer 4.

[0019] As shown in Figure 4, the horizontal cross section of the outer protecting layer 4 is of a racetrack shape, which is different from that shown in Figure 2. Accordingly, the corresponding stiffening beam 3 is also of a corresponding racetrack shape.

[0020] As shown in Figure 5, the horizontal cross section of the outer protecting layer 4 is of a rectangular shape, which is different from that shown in Figure 2. Accordingly, the corresponding stiffening beam 3 is also of a corresponding rectangular shape, with four corner areas being rounded smoothly. The buffering assemblies are uniformly arranged between adjacent stiffening beams 3 and connected thereto.

Example 2

[0021] As shown in Figures 5 and 6, in the outer protecting layer 4 of Example 2 eight buffering assemblies are arranged along the vertical direction. The horizontal cross section of the outer protecting layer 4 is circular, and that of the stiffening beam 3 is annular accordingly. Each buffering assembly includes three stiffening beams 3, one horizontally nested within another in turn. The innermost horizontal stiffening beam 3 embraces the bridge pier 8 tightly. Similar with the connection between the buffer member 2 and the stiffening beam 3 in Example 1, in Example 2 the innermost stiffening beam 3 is connected with the intermediate stiffening beam 3 through buffer members 2, while the intermediate stiffening beam 3 is in turn connected with the outermost stiffening beam 3 through buffer members 2. The crossed ends of the buffer members 2 are located towards the outside in each case. Shock absorbing rubber elements 5 are arranged between vertically adjacent inner stiffening beams 3, in which adjacent shock absorbing rubber elements 5 are arranged in a stagger manner along the vertical direction. The shock absorbing rubber elements 5 are connected with the innermost stiffening beams 3 at the upper and lower sides, and surround the bridge pier 8 tightly via rivets. Suspended draglines 6 are provided on the outermost horizontal stiffening beam 3 of the top buffering assembly. The suspended draglines 6 are connected to the upper part of the bridge pier 8. The dustproof cover board 7 is arranged on the top of the outer protecting layer 4, which can be, but not limited to, of circular shape.

Example 3

[0022] As shown in Figures 8, 9 and 10, the protection apparatus in Example 3 is designed mainly for interchange triangular zone. The interchange triangular zone, a diverging site for vehicles and more possibly hit by ve-

hicles, includes a front protecting column 9 and a rear protecting mound 10. As shown in Figure 9, the front protecting column 9 is cylindrical, and the safety protection apparatus arranged thereon surrounds the front end of the protecting column 9 (against the direction in which cars drive) half around. The outer protecting layer 4 of the safety protection apparatus has a semi-circular cross section. Each buffering assembly inside the outer protecting layer 4 includes three stiffening beams 3, which are arranged from inside to outside horizontally and are shaped as semi-circular accordingly. Three stiffening beams 3 are connected with each other in sequence via buffer members 2. Shock absorbing rubber elements 5 are arranged between vertically adjacent stiffening beams 3 and connected thereto, and surround the protecting column 9. In addition, the bottom of the outer protecting layer 4 can be directly buried or fixed to the road surface, or fixed to the substrate on the road surface at its lower end through fasteners. In this case, no suspended draglines 6 are necessary. As seen from Figure 8, the rear protecting mound 10 includes a wall body having a rectangular cross section and a semi-cylinder connected thereto. Therefore, the outer protecting layer 4 of the safety protection apparatus has a U-shaped cross section. As for the semi-cylinder, the stiffening beams 3 therein are also shaped as semi-circular correspondingly. Due to the smaller diameter of the semi-cylinder, the semi-cylinder is provided with four stiffening beams 3, each adjacent two of them being connected with each other through buffer members 2. As for the wall body which is relatively wider than the semi-cylinder, two stiffening beams 3 are provided on both sides, which may be hit, of the wall body of the protecting mound 10, and are connected thereto through buffer members 2. Moreover, two inner stiffening beams 3 are connected together to form one single body. Finally, shock absorbing rubber elements 5 are arranged between vertically adjacent inner stiffening beams 3 respectively. During high speed collision, the car will first hit the safety protection apparatus on the front protecting column 9. Even though the front protection apparatus is damaged due to the high speed collision by the car and thus the car unavoidably hits the safety protection apparatus on the rear protecting mound 10, the speed of the car will be reduced rapidly due to a considerably long time period of collision. In addition, the rear protection apparatus can also consume the energy from the collision through deformation, and thus the final impact force is lowered enough such that the interchange triangular zone can resist. Therefore, the peak load during collision can be effectively eliminated, and the damage of vehicles and structures hit in collision can be effectively avoided or mitigated, while the collision towards structures is buffered.

Example 4

[0023] As shown in Figures 11 and 12, the outermost stiffening beam 3 of the top buffering assembly of the

safety protection apparatus in Example 4 is suspended from and connected to the bridge pier 8 through suspended draglines 6. The suspended draglines 6 can hang up the whole safety protection apparatus through the firm connection between the outermost stiffening beam 3 and the outer protecting layer 4. As regard to some stand columns which are similar to bridge piers, different landscape decorations 11 can be provided on the top thereof to improve the appearance of the columns. For example, a landscape decoration showing carps jumping over the dragon gate can be adopted, and the suspended draglines 6 can be connected thereto. To facilitate mount and replacement, the dustproof cover board 7 provided on the top side of the outer protecting layer 4 can be designed as an individual modular unit, which can be connected with the outer protecting layer 4 via aluminium rivets. The aluminium rivets will be sheared off when a collision occurs, and the dustproof cover board 7 will be collapsed without affecting the deformation of the protection apparatus. In addition, the edges of the dustproof cover board 7 are smoothly curled so that no acute angle is present at the collision area. Therefore, the impact range is expanded, and the safety of cars and ships are effectively ensured.

[0024] The present invention is not limited to the above discussed examples. Structures similar to bridge piers 8, protecting columns 9, protecting mounds 10 and the like that require protection are considered suitable for use of the safety protection apparatus of the invention.

List of reference numbers

- 1 damping spoke
- 2 buffer member
- 3 stiffening beam
- 4 outer protecting layer
- 5 shock absorbing rubber element
- 6 suspended dragline
- 7 dustproof cover board
- 8 bridge pier
- 9 protecting column
- 10 protecting mound
- 11 Landscape decoration

Claims

1. A safety protection apparatus of elastic-plastic steel structure, including an outer protecting layer (4) and buffering assemblies arranged in a layered manner along the vertical direction and fixed within the outer protecting layer (4), wherein each buffering assembly includes stiffening beams (3) distributed in a layered manner along the horizontal direction and buffer members (2) uniformly bridging between adjacent stiffening beams (3), each of said buffer members (2) comprises a pair of

arc-shaped damping spokes (1) fastened to each other, one end of one of the damping spokes is crossed with one end of the other damping spoke; said buffer members (2) of adjacent buffering assemblies are arranged in a stagger manner with each other along the vertical direction, and shock absorbing rubber elements (5) are provided between vertically adjacent stiffening beams (3), wherein vertically adjacent shock absorbing rubber elements (5) are arranged in a stagger manner with each other.

2. The safety protection apparatus of elastic-plastic steel structure according to claim 1, wherein said buffer members (2) are provided on both the upper side and the lower side of said stiffening beams (3), and the buffer members (2) on the upper side are arranged in a stagger manner along the vertical direction relative to those on the lower side.

3. The safety protection apparatus of elastic-plastic steel structure according to claim 1 or 2, wherein the crossed ends of said pair of damping spokes (1) are connected with outer horizontal stiffening beam (2), while the other ends are connected with adjacent inner horizontal stiffening beam (3).

4. The safety protection apparatus of elastic-plastic steel structure according to claim 1, wherein a dustproof cover board (7) is provided on the top of said outer protecting layer (4).

5. The safety protection apparatus of elastic-plastic steel structure according to claim 1, wherein suspended draglines (6) are provided on the outer horizontal stiffening beam (3) of top buffering assembly.

6. The safety protection apparatus of elastic-plastic steel structure according to claim 3, wherein said damping spoke (1) is made from elastic-plastic mild steel.

7. The safety protection apparatus of elastic-plastic steel structure according to claim 6, wherein said damping spoke (1) has a longitudinal cross section of C shape, semi-ellipse shape, nonlinear arc shape or the like.

8. The safety protection apparatus of elastic-plastic steel structure according to claim 7, wherein said stiffening beam (3) is connected with the damping spoke (1) via pins or rivets.

9. The safety protection apparatus of elastic-plastic steel structure according to claim 1 or 3, wherein said outer protecting layer (4) is made by high-ductile steel plate with vulcanized rubber thereon.

10. The safety protection apparatus of elastic-plastic steel structure according to claim 8, wherein the transverse cross section of the outer protecting layer (4) is of a closed shape or a linear shape.

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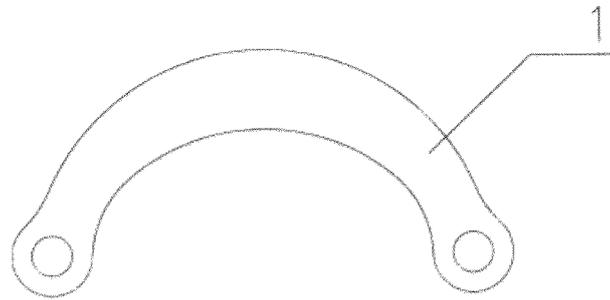


Fig. 1

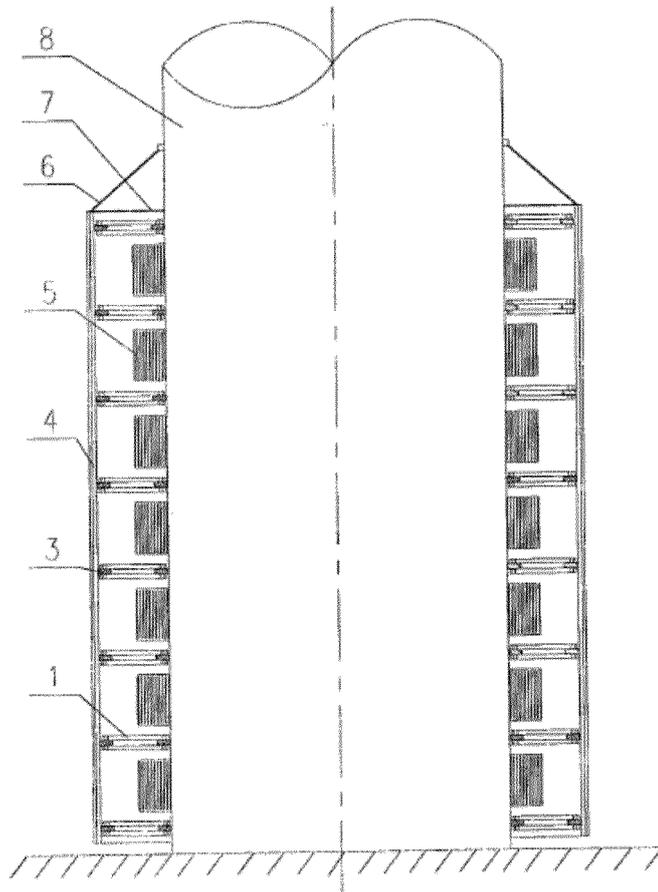


Fig. 2

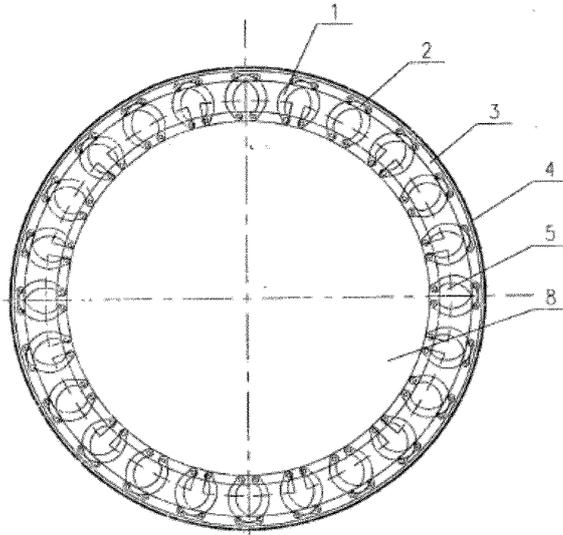


Fig. 3

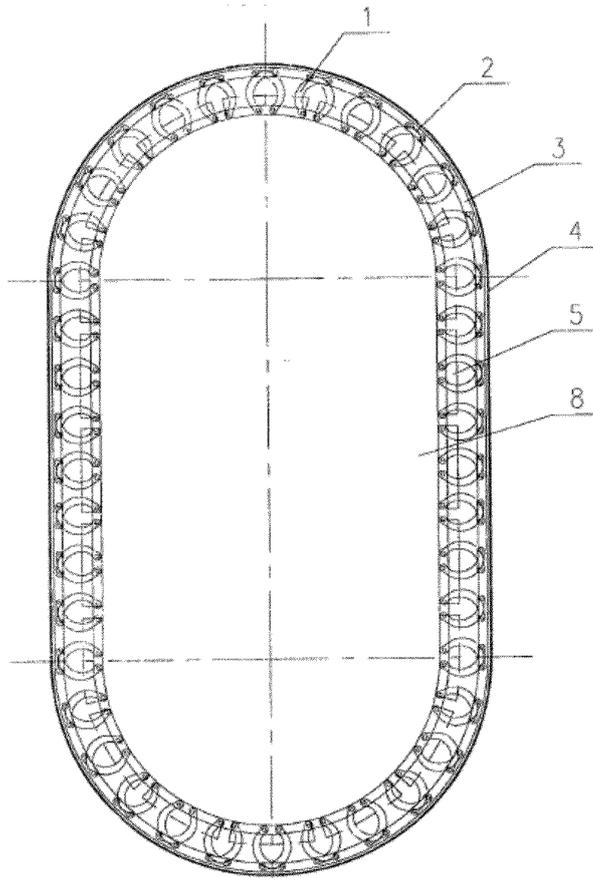


Fig. 4

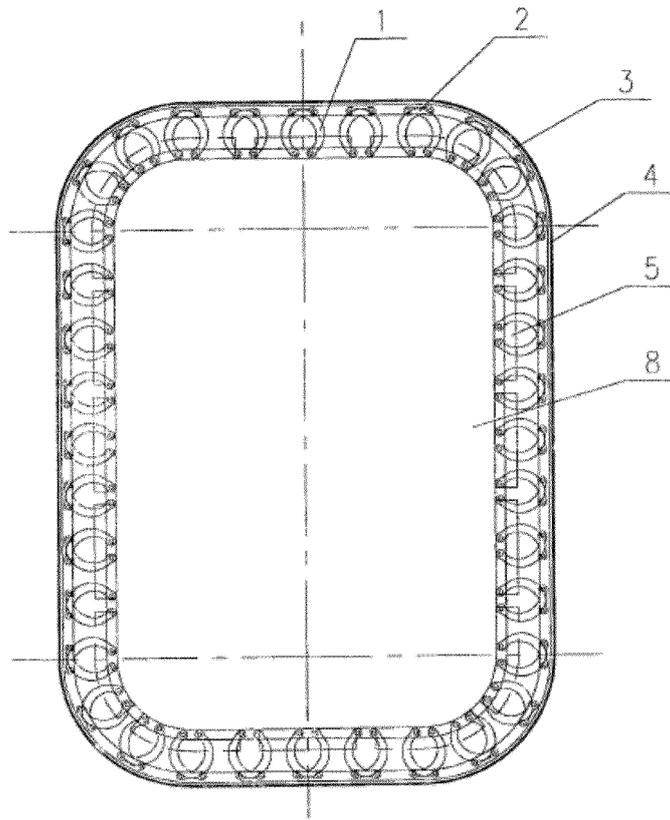


Fig. 5

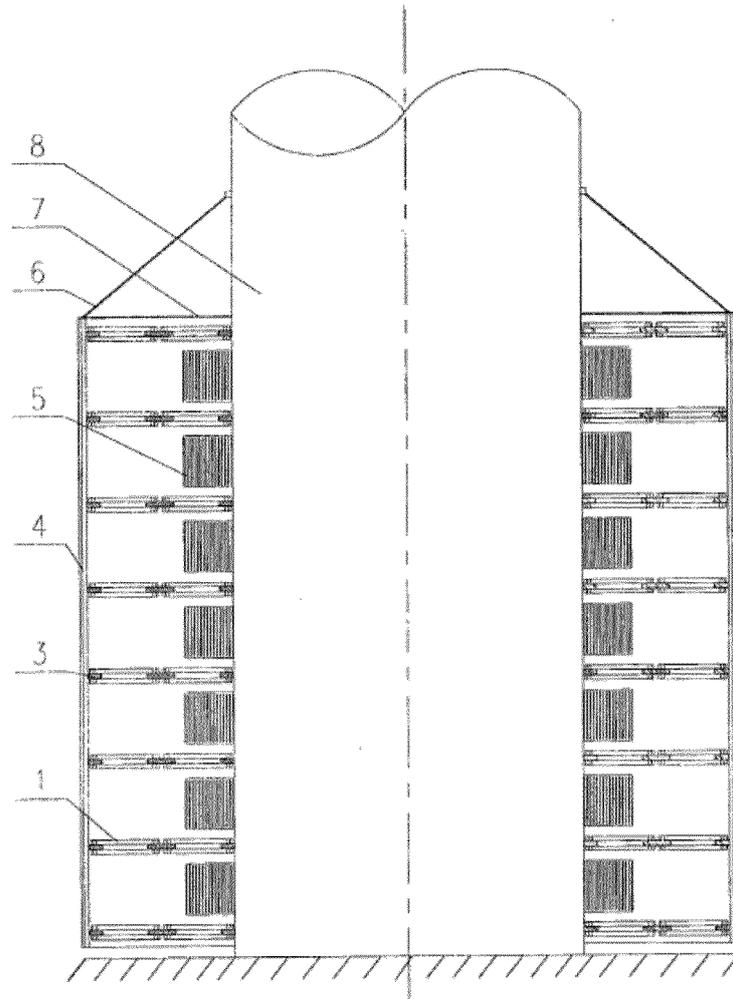


Fig. 6

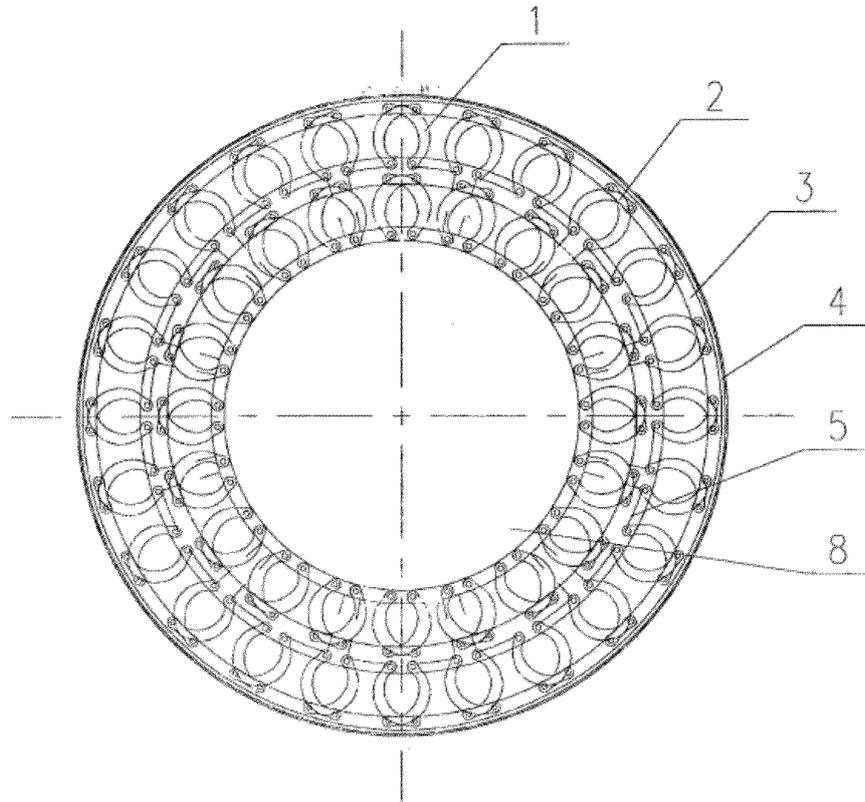


Fig. 7

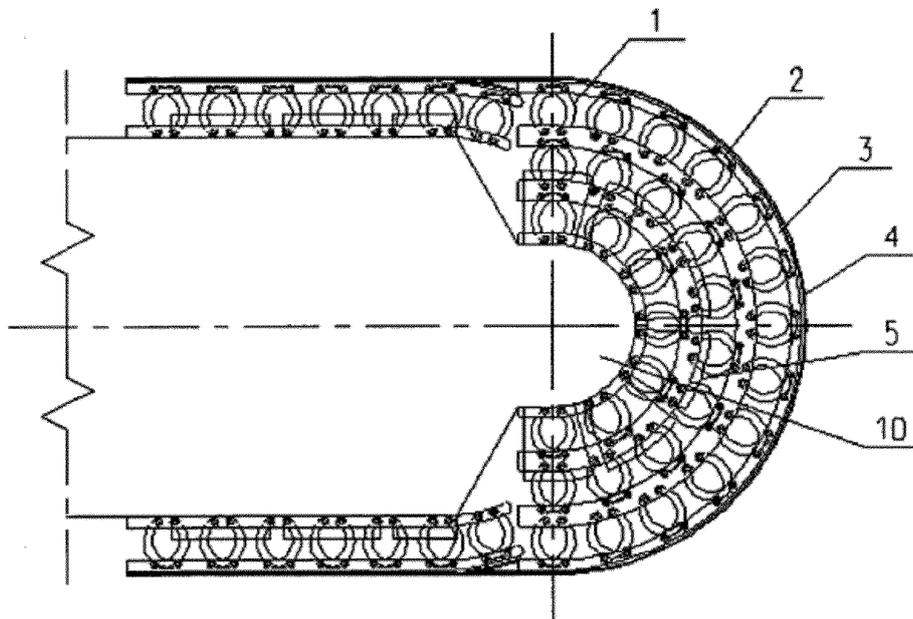


Fig. 8

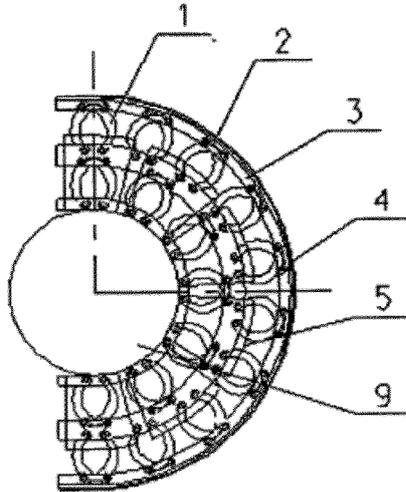


Fig. 9

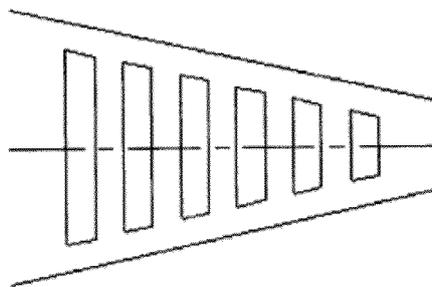


Fig. 10

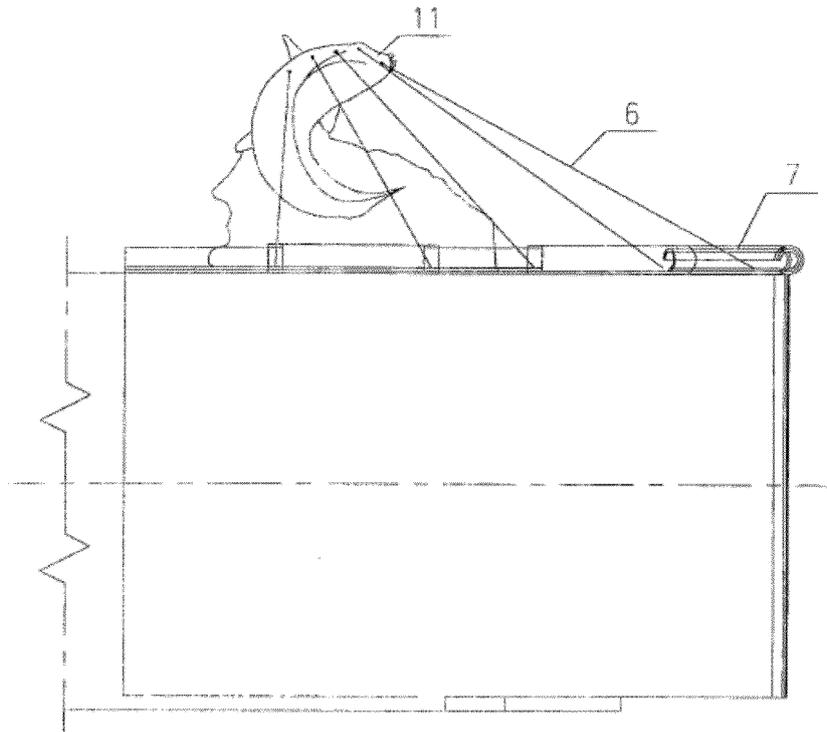


Fig. 11

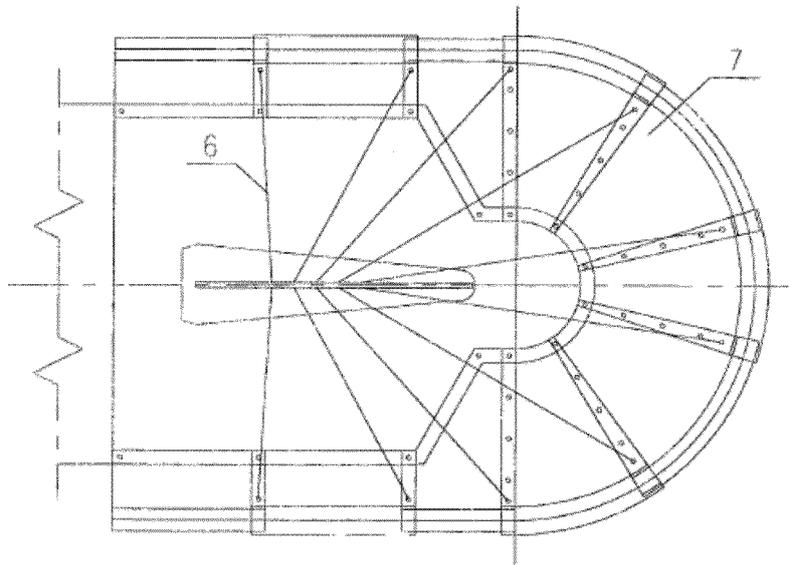


Fig. 12

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2010/001566

A. CLASSIFICATION OF SUBJECT MATTER		
E01F 15/14 (2006.01) i		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
IPC:E01F15/14, E01F15/00, E01D19/02		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
CNPAT,CNKI,WPI,EPODOC: elastic+, flexibility, buffer+, bumper, rubber, steel, absorb+, impact+, amortize, pier, pillar, reinforce, arc		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN1990957A (HANAI MFG CO LTD) 04 Jul.2007 (04.07.2007) page 7 line 15 to page 8 line 17 of the description, fig. 2	1-10
A	CN101555683A (CCCC FIRST HIGHWAY CONSULTANTS) 14 Oct.2009 (14.10.2009) the whole document	1-10
A	CN201077966Y (TAN, Xinghua) 25 Jun. 2008 (25.06.2008) the whole document	1-10
A	US4072022A (TOKYO FABRIC KOGYO KK) 07 Feb.1978 (07.02.1978) the whole document	1-10
A	US3104875A (L.A.DOYLE) 24 Sep.1963 (24.09.1963) the whole document	1-10
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
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“P” document published prior to the international filing date but later than the priority date claimed		
Date of the actual completion of the international search	Date of mailing of the international search report	
15 Apr.2011(15.04.2011)	26 May 2011 (26.05.2011)	
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer LI,Quanxiao Telephone No. (86-10) 62085426	

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INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US1341219A (H.N.RIDGWAY) 25 May 1920 (25.05.1920) the whole document	1-10
A	DE3608169A1 (SCHLITTER GEORG) 24 Sep.1987 (24.09.1987) the whole document	1-10

Form PCT/ISA /210 (continuation of second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2010/001566

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN1990957A	04.07.2007	JP2007170109 A	05.07.2007
		CN200971477Y	07.11.2007
CN101555683A	14.10.2009	None	
CN201077966Y	25.06.2008	None	
US4072022A	07.02.1978	JP52046638A	13.04.1977
		JP52071239U	27.05.1977
US3104875A	24.09.1963	None	
US1341219A	25.05.1920	None	
DE3608169A1	24.09.1987	None	

Form PCT/ISA /210 (patent family annex) (July 2009)