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(54) **DAMPING DEVICE**

(57) The claimed damping device belongs to a group of safety devices that help to decelerate and stop a vehicle

The damping device containing a front deflector representing a movable support installed on a guide with possibility of movement, sections of mass dampers and sectional side beams designed to provide the telescopic insertion of the front section of the side beam into the next one behind it. Each pair of sections of right and left side beams is limited by a horizontally oriented rectangular frame on a vertical base entering into a guide and fixed between relevant sections of right and left side beams. Ultimate rectangular frame of the damping device serves as a rear block, which is equipped with a rear fastening device rigidly connected to the guide. Damping device may contain mass dampers of the first and the second types. Each section of the mass damper of the first type is formed by twin vertical non-contacting sheet elements with zigzag shaped bends oriented towards each other, whereas each end of each element with zigzag shaped bend is bent outwards forming a through channel parallel to the centre line of the damping device. Each section of the mass damper of the second type represents a perforated end-to-end duct oriented horizontally relative to a through opening and perforation is made on each of four duct walls and at bends, with per-

foration at bends coming to both adjacent sides of the duct. Each section is limited by vertical plates, while several vertical plates rest on a lower bar of each rectangular frame. Front and rear vertical plates are fixed at front deflector and rear fastening, respectively. Sections of mass dampers of two types may be located in series. Sections of mass dampers of two types may be located alternately.

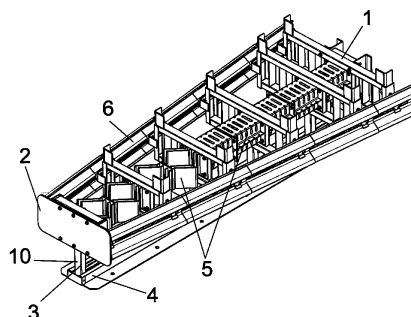


Fig. 3

Description

Pertinent art

[0001] The claimed damping device belongs to a group of safety devices that help to decelerate and stop a vehicle.

Related Art

[0002] "Front road damping barrier and relevant damping cartridge" is known from prior art (see Russian invention patent No. 2434763, IPC E01F15/14).

[0003] Front damping fencing for motor vehicles contains a frame with elements for fastening to a vehicle or to a stationary structure and a damping cartridge connected to the frame. Damping cartridge includes a casing with energy absorbing devices to withstand the impact after a vehicle collision. Rear part of the damping cartridge is intended for contact with a vehicle colliding with a barrier. Middle part - for the vehicle deceleration and kinetic energy absorption due to deformation and destruction of energy absorbing devices. Front part - for cartridge deformation restriction and for fastening to the base component of the road front barrier. Energy absorbing device of the cartridge middle part deformed in case of collision are formed by vertical corrugated sheet elements with swages oriented in reverse direction relative to the longitudinal axis of the cartridge and in a return direction relative to one another near adjacent elements. The swages of corrugated sheet elements are formed by webs and vertical flanges. Adjacent corrugated sheet elements are interconnected at vertical flanges directly or through flat sheet binders forming cells between slanted webs and flanges of adjacent corrugated sheet elements. Front part of the cartridge located at the side of a base component of the road front barrier is made in the form of a frame with a rigid transverse element. Rear part of the cartridge represents a three-dimensional module of thin sheet material having a trapezoidal cross-section and filled with porous material. Vertical flange of the three-dimensional module is connected to vertical flanges of the adjacent corrugated sheet element of the cartridge middle part. Thus, better safety of the front vehicle damping barrier is achieved.

[0004] The drawback of this device is a complexity of its fabrication.

[0005] The closest to the claimed invention is the RF patent for utility model No. 66356, IPC E01F9 / 00; E01F15/00, "Inertial road damping system". Inertial road damping system contains a front deflector representing a shifting buttress support installed on guides with possibility of motion required for damping of impact energy in case of collision. Damping is achieved through "dry" friction of moving mass dampers represented by linked plates located between guides and driven by a system of wire ropes connected to a deflector, while the reverse reaction of the damping system is excluded.

[0006] The drawback of this technical solution is the need for calculation of the number of plates/moving loads and rather rigid impact in case of a collision with a vehicle, which may result in injuries to a driver and passengers.

Disclosure of the Invention

[0007] The objective of the offered damping device is to design a damping device providing uniform deceleration of vehicles and minimum damage to vehicles and people inside in case of a collision also functioning as a barrier railing.

[0008] The objective is achieved through the use of: damping device containing a front deflector representing a movable support installed on a guide with possibility of movement, sections of mass dampers and sectional side beams produced with a possibility of telescopic insertion of side beam section in front into the section behind it. Each pair of sections of right and left side beams is limited by a horizontally oriented rectangular frame on a vertical base entering into a guide and fixed between relevant sections of right and left side beams. Ultimate rectangular frame of the damping device serves as a rear block, which is equipped with a rear fastening device rigidly connected to the guide. Damping device may contain mass dampers of the first and the second types. Each section of the mass damper of the first type is formed by twin vertical non-contacting sheet elements with zigzag shaped bends oriented towards each other, whereas each end of each element with zigzag shaped bend is bent outwards forming a through channel parallel to the centre line of the damping device. Each section of the mass damper of the second type represents a perforated end-to-end duct oriented horizontally relative to a through opening and perforation is made on each of four duct walls and at bends, with perforation at bends coming to both adjacent sides of the duct. Each section is limited by vertical plates, while several vertical plates rest on a lower bar of each rectangular frame. Front and rear vertical plates are fixed at front deflector and rear fastening, respectively. Sections of mass dampers of two types may be located in series. Sections of mass dampers of two types may be located alternately.

Brief description of figures and drawings

[0009] The essence of the invention is explained by drawings, where

Figure 1 - General view of damping device with mass damper sections of the first type.

Figure 2 - General view of damping device with mass damper sections of the second type.

Figure 3 - General view of damping device with mass damper sections of the first and the second type.

Figure 4 - Top view of trapezoidal damping device with mass damper sections of the first type.

Figure 5 - Top view of rectangular damping device

with mass damper sections of the first type.

Figure 6 - Top view of trapezoidal damping device with mass damper sections of the second type.

Figure 7 - Top view of rectangular damping device with mass damper sections of the second type.

Figure 8 - Top view of trapezoidal damping device with mass damper sections of the first and second types.

Figure 9 - Top view of rectangular damping device with mass damper sections of the first and second types.

Figure 10 - Side view of damping device.

Figure 11 - Front view of trapezoidal damping device.

Figure 12 - Front view of rectangular damping device.

Figure 13 - Rear view of trapezoidal damping device.

Figure 14 - Rear view of rectangular damping device.

Figure 15 - Load-shift diagram is executed.

[0010] Damping device 1 containing front deflector 2 representing a movable support 3 installed on guide 4 with possibility of movement, sections of mass dampers 5 and sectional side beams 6 providing for telescopic insertion of side beam section in front into the section behind it (see Fig. 1, 2, 3).

[0011] Each pair of beams in right (7) and left (8) side sections is limited by horizontally oriented rectangular frame 9 on vertical base 10 inserted into the guide 4 and fixed between relevant side sections of right (7) and left (8) side beams. Ultimate rectangular frame 11 of damping device is rear block 12 and is equipped with rear fastening device 13 rigidly connected to guide 4 (see Fig. 1, 2, 3, 10, 11, 12).

[0012] Damping device may contain mass dampers of the first and the second types.

[0013] Each section of mass damper 14 of the first type is formed by twin vertical non-contacting sheet elements 15 with zigzag shaped bends 16 oriented towards each other, while each end 17 of each element 15 with zigzag shaped bend 16 is bent outwards forming through channel 18 parallel to centre line of damping device 1 (see Fig. 1, 4, 5,).

[0014] Each section of mass damper 19 of the second type represents perforated end-to-end duct 20 oriented horizontally relative to through opening 21 and perforation 22 is made at each of four duct (20) walls and at bends, with perforation (22) at bends coming to both adjacent sides of duct 20 (see Fig. 2, 6, 7).

[0015] Each section 5 is limited by vertical plates 23, while several vertical plates 23 rest on lower bar 24 of each rectangular frame 9. Front and rear vertical plates 23 are fixed at front deflector 2 and rear fastening 13, respectively. Sections of mass dampers 5 of two types may be located in series. Sections of mass dampers 5 of two types may be located alternately (see Fig. 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12).

[0016] The damping device operates as follows:

1. In case of a vehicle collision against front deflector 2, mass dampers of the first type 14 and the second type 19 smoothly work for compression.

2. Zigzag-shaped mass damper 14 of the first type is compressed in the area of a zigzag-shaped bend 16, and the smoothness of compression is ensured by its twin configuration.

3. Mass damper 19 of the second type represented by perforated duct 20 is compressed in the area of perforated holes 22, while smoothness of compression is ensured because perforation 22 is applied uniformly along the whole duct 20 and at bends.

4. When a combination of the two types of mass dampers, zigzag and perforated duct 20, is used, damping device 1 can operate with maximum efficiency having both the features of type one 14 and type two 19 mass dampers.

5. The offered damping device 1 operates efficiently both in case of a frontal collision against front deflector 2 and in case of a tangential collision due to the proposed configuration of type one and two mass dampers, the design of which allows them to bend unevenly at such impact, for example, to a greater extent from one side or another, and also due to the presence of sectional side beams 6.

[0017] The device is assembled as follows:

1. Pre-assemble the frame of damping device 1 and sections with mass dampers 5 separately.

2. The assembly of mass damper sections 5 is simple and requires no special skills or special tools; only one set of road worker tools is needed, e. g. wrenches, bolts, nuts, etc.

3. Connect mass damper sections with each other through vertical plates 23, e. g. using bolted connection.

4. Bolted connection is also used to fix the mass damper sections 5 of damping device 1 to rectangular frames 9 and further on guide 4.

5. When assembling sections of mass dampers 5, a variable combination of sections of both types of mass dampers can be used, for example, with zigzag mass dampers, then the next one with a mass damper in the form of perforated duct 20 and then again with zigzag mass dampers. Thus, the combination of sections with mass dampers of the first and second types may vary.

[0018] The proposed design has the following advantages over the prototype:

1. Sections of mass dampers operate at a constant load (see Fig. 15, load-shift diagram), i. e. the load increases rapidly in case of collision and impact against the front deflector, but, after the load is transferred to the system of mass dampers, overload oscillations are minimized and the vehicle decelerates

uniformly. Due to such operation of the proposed damping device, short-term overloads are minimized and overall inertial overload is less than 1.

2. Damages incurred by vehicles in case of a collision with the proposed damping device allow maintaining flail space of a vehicle.

3. If the collision speed is less than 50 km/h, damages are insignificant and allow the vehicle to continue motion by its own.

4. The proposed damping device operates both in case of a direct frontal collision and in case of a tangential collision.

5. Damping device is reusable, since after damages incurred at a collision of a vehicle only the mass damper sections need to be replaced.

6. Preservation factor of the proposed damping device is at least 75%, which allows reducing the cost of replacement of damaged damping devices.

Maintenance:

[0019]

1. Since the damping device is reusable, it is serviceable, while maintenance requires no special skills or special tools; only one set of road worker tools is needed, e. g. wrenches, bolts, nuts, etc.

2. In fact, the maintenance itself implies replacement of spent sections of mass dampers.

[0020] Thus, the objective of creating a damping device of uniform deceleration ensuring and minimum damage to vehicles and people inside in case of a collision, also having the function of a safety railing, has been resolved.

Industrial Applicability

[0021] Effective operation of the proposed damping device ensured by an integrity of its attributes confirms industrial applicability of the claimed invention.

List of items:

[0022]

1. damping device
2. front deflector
3. moving support
4. guide
5. section of mass dampers
6. sectional side beam
7. right sectional side beam
8. left sectional side beam
9. horizontal rectangular frame
10. vertical base
11. terminal rectangular frame
12. rear block

13. rear fastening
14. section of mass dampers of the first type
15. sheet element
16. zigzag-shaped bend
17. end of sheet element
18. through channel
19. section of mass dampers of the second type
20. perforated end-to-end duct
21. through opening
22. perforation
23. vertical plate
24. lower bar of rectangular frame

15 Claims

1. Damping device containing a front deflector representing a moving support installed at a guide with possibility for movement and a section of mass dampers, whereas, damping device is additionally equipped with sectional side beams designed to provide the telescopic insertion of the front section of the side beam into the next one behind it, while each pair of right and left side beam sections is limited by a horizontally oriented rectangular frame on a vertical base incorporated into guide and fixed between relevant sections of side right and left beams, while terminal rectangular frame of damping device represents a rear block and is fitted with rear fastening rigidly connected to guide, while each mass damper section is formed by twin vertical non-contacting sheet elements with zigzag-shaped bends, oriented towards each other, while each end of each element with zigzag-shaped bend is bent outwards forming a through channel parallel to the centre line of the damping device and the section is limited by vertical plates, while some vertical plates rest on lower bar of each rectangular frame and front and rear vertical plates are fixed at front safety barrier and rear fastening, respectively.

2. Damping device containing a front deflector representing a moving support installed at a guide with possibility for movement and a section of mass dampers, whereas, damping device is additionally equipped with sectional side beams designed to provide the telescopic insertion of the front section of the side beam into the next one behind it, while each pair of right and left side beam sections is limited by a horizontally oriented rectangular frame on a vertical base incorporated into guide and fixed between relevant sections of side right and left beams, while terminal rectangular frame of damping device represents a rear block and is fitted with rear fastening rigidly connect-

ed to guide, while each mass damper section represents a perforated end-to-end duct oriented horizontally relative to a through opening and perforation is made at each of four duct walls and at bends, with perforation at bends coming to both adjacent sides of duct, and the section is limited by vertical plates, while some vertical plates rest on lower bar of each rectangular frame and front and rear vertical plates are fixed at front deflector and rear fastening, respectively.

3. Damping device containing a front deflector representing a moving support installed at a guide with possibility for movement and a section of mass dampers,

whereas, damping device is additionally equipped with sectional side beams designed to provide the telescopic insertion of the front section of the side beam into the next one behind it, while each pair of right and left side beam sections is limited by a horizontally oriented rectangular frame on a vertical base entering into a guide and fixed between relevant sections of side right and left side beams, while terminal rectangular frame of damping device represents a rear block and is fitted with rear fastening rigidly connected to guide, while damping device has two types of mass damper sections, where each mass damper section of the first type is formed by twin vertical non-contacting sheet elements with zigzag-shaped bends, oriented towards each other, while each end of each element with zigzag-shaped bend is bent outwards forming a through channel parallel to centre line of damping device and the section is limited by vertical plates, whereas each mass damper section of the second type represents a perforated end-to-end duct oriented horizontally relative to a through opening and perforation is made at each of four duct walls and at bends, with perforation at bends coming to both adjacent sides of duct, while some vertical plates limiting the section rest on lower bar of each rectangular frame and front and rear vertical plates are fixed at front deflector and rear fastening, respectively.
4. Damping device per claim 3, wherein the sections of mass dampers of two types are located in series.
5. Damping device per claim 3, wherein the sections of mass dampers of two types are located alternately.

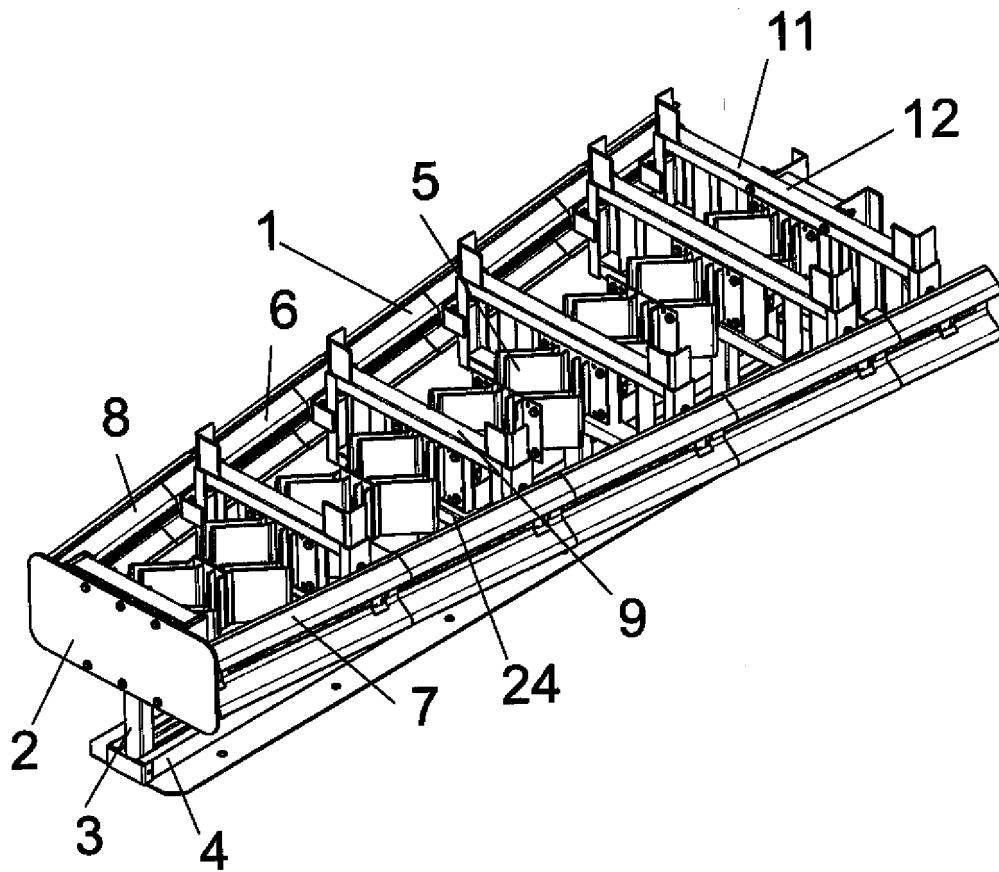


Fig. 1

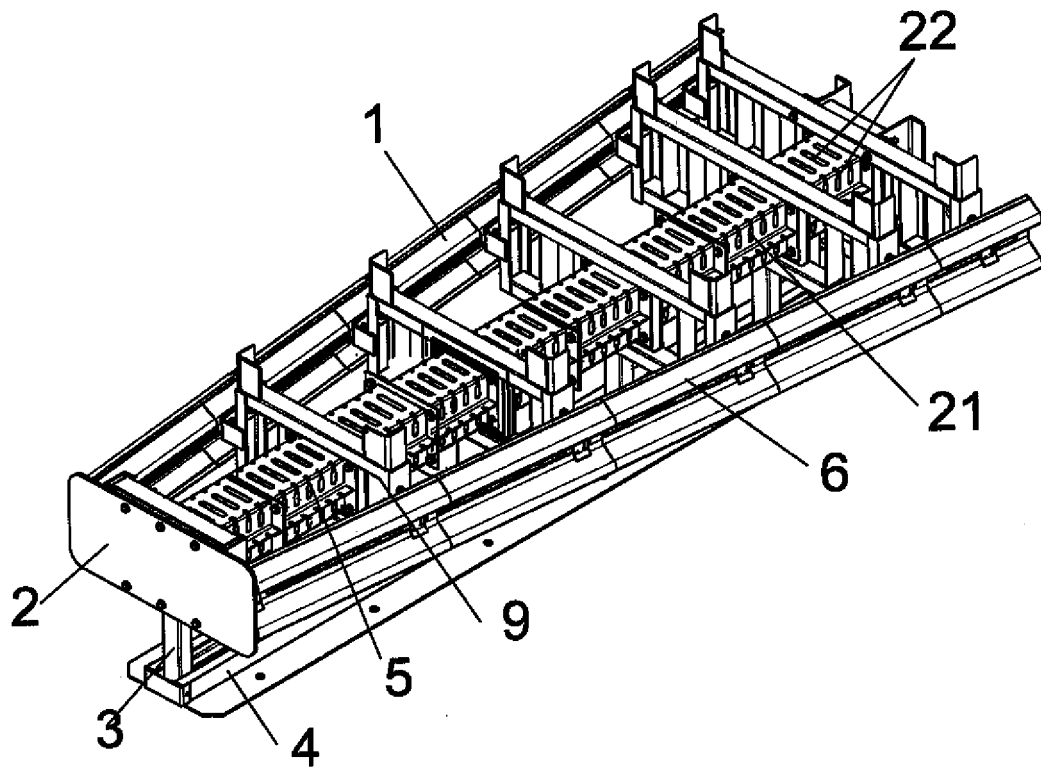


Fig. 2

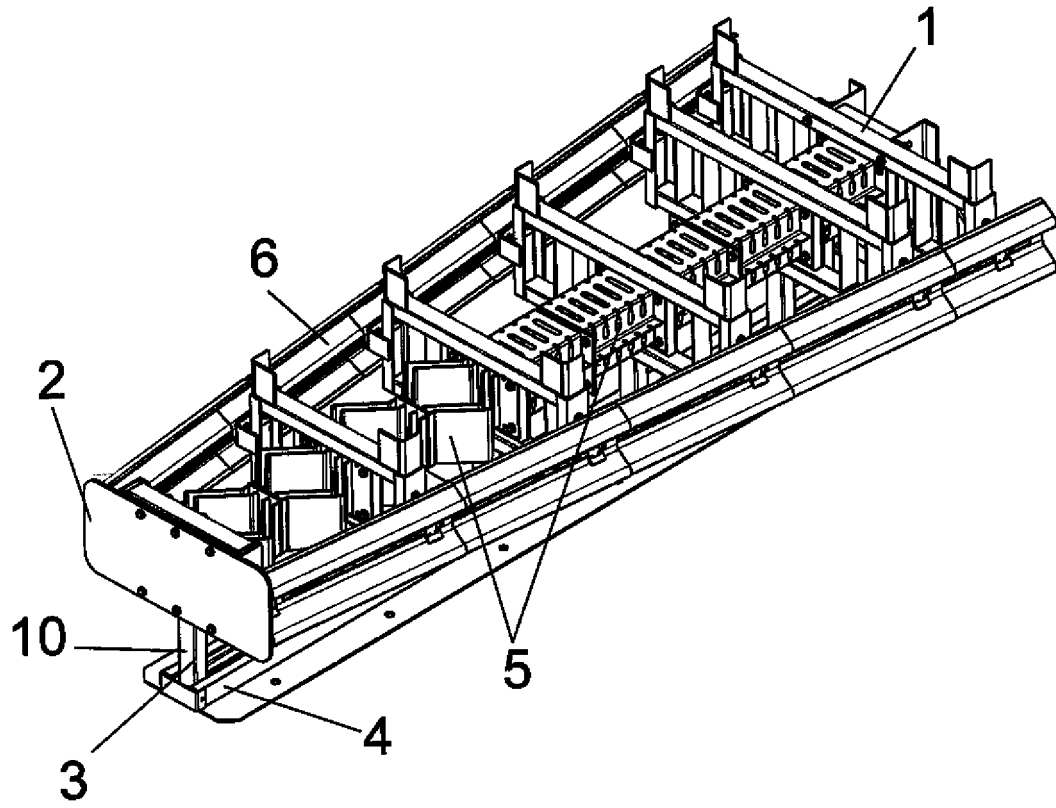


Fig. 3

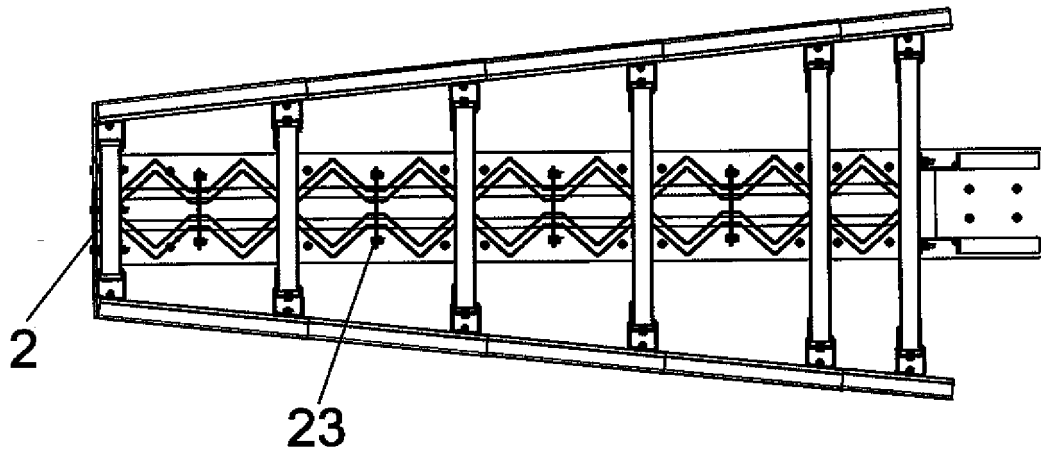


Fig. 4

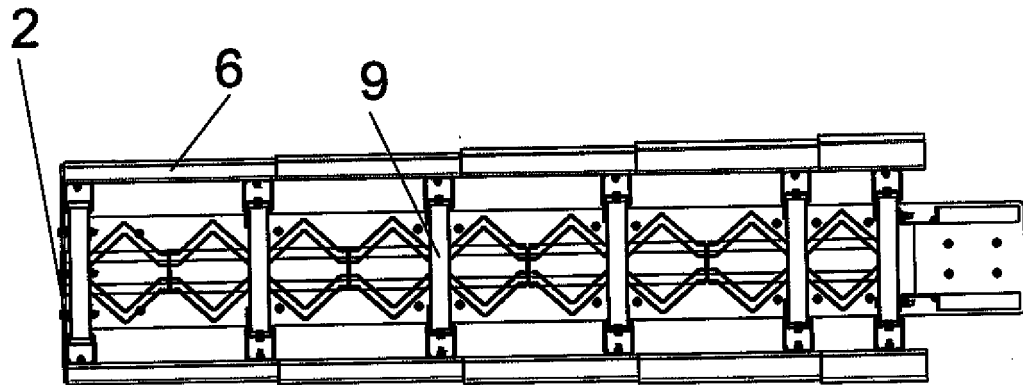


Fig. 5

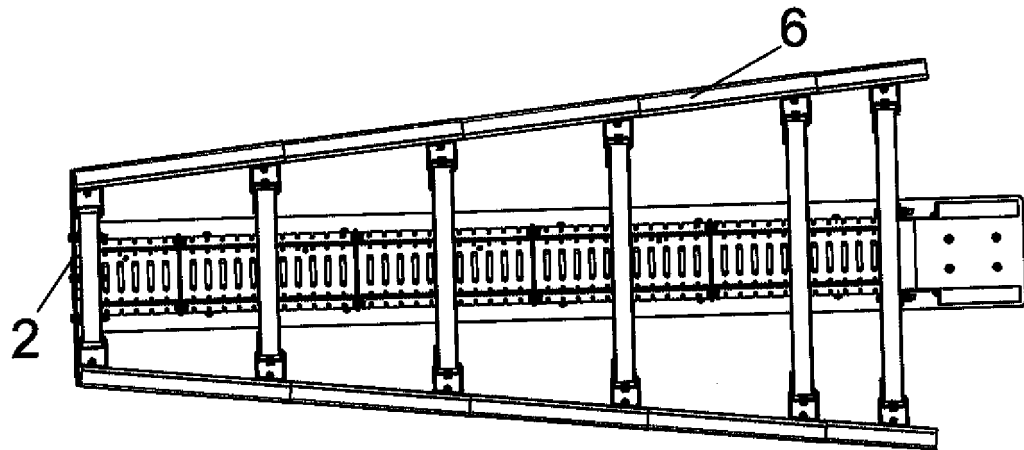


Fig. 6

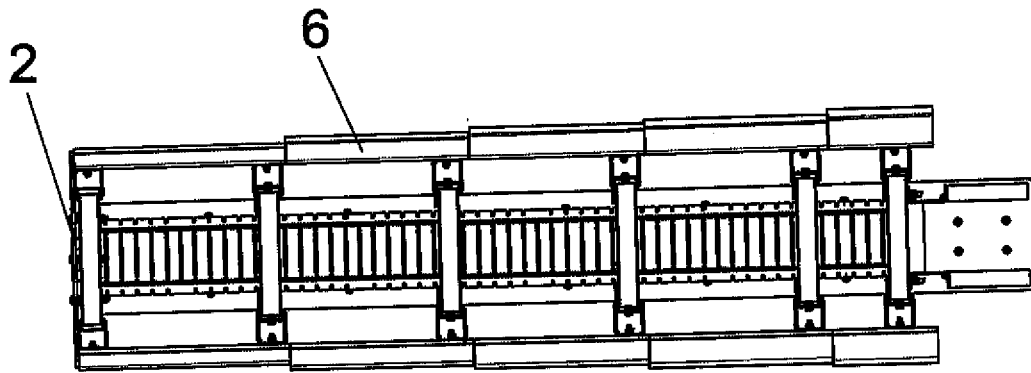


Fig. 7

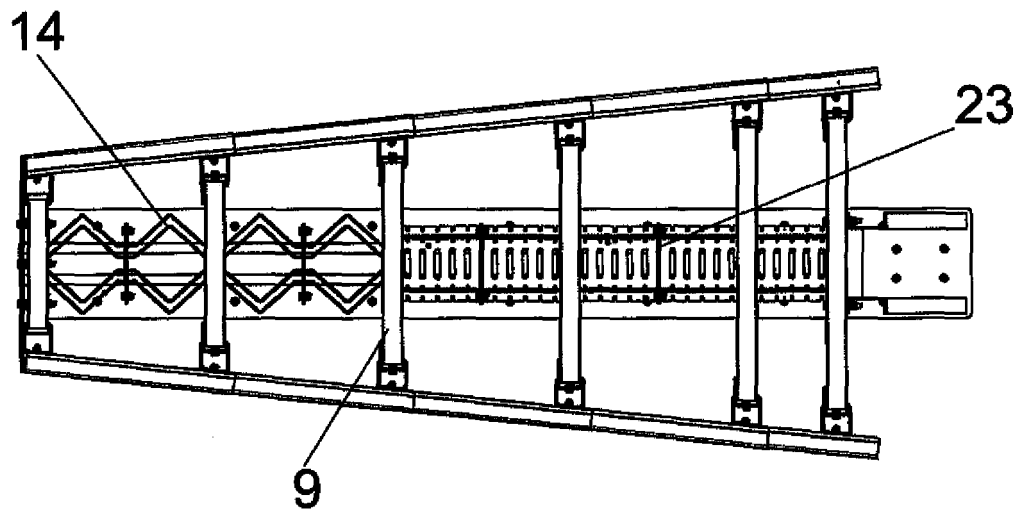


Fig. 8

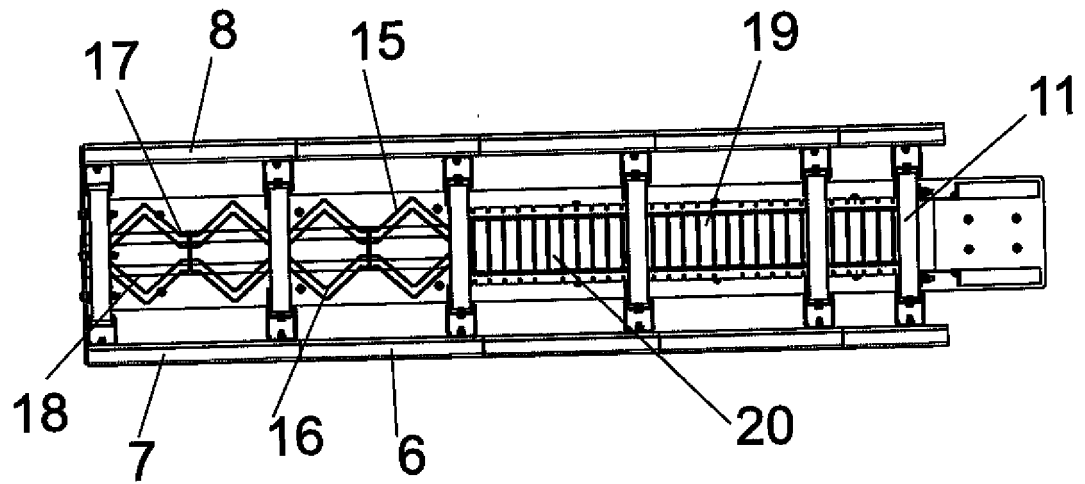


Fig. 9

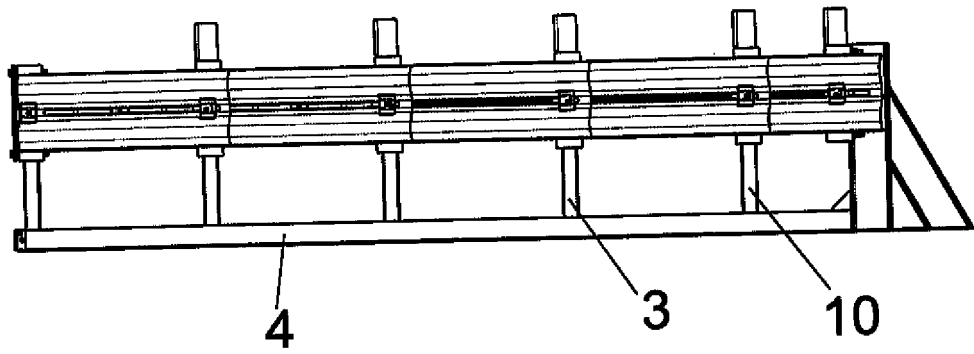


Fig. 10

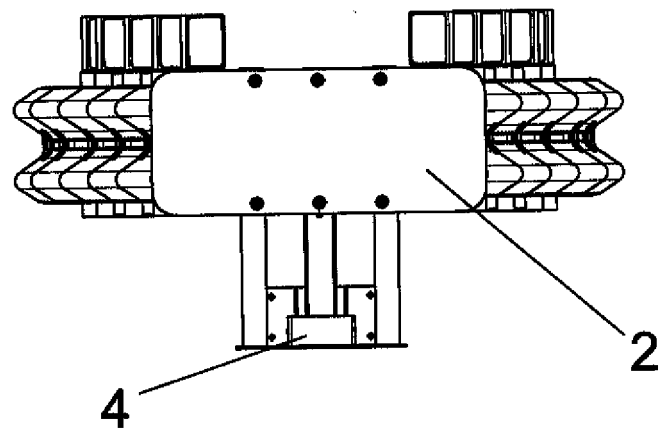


Fig. 11

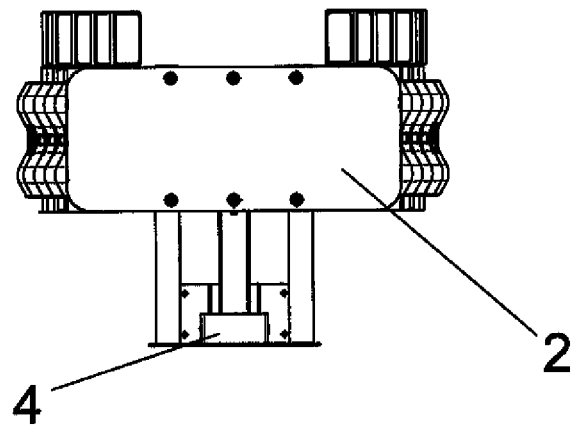


Fig. 12

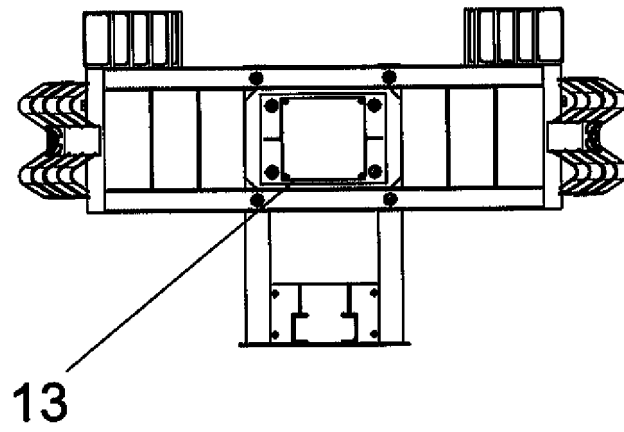


Fig. 13

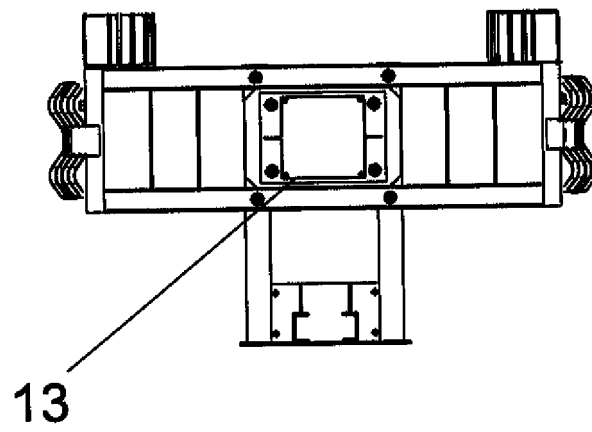


Fig. 14

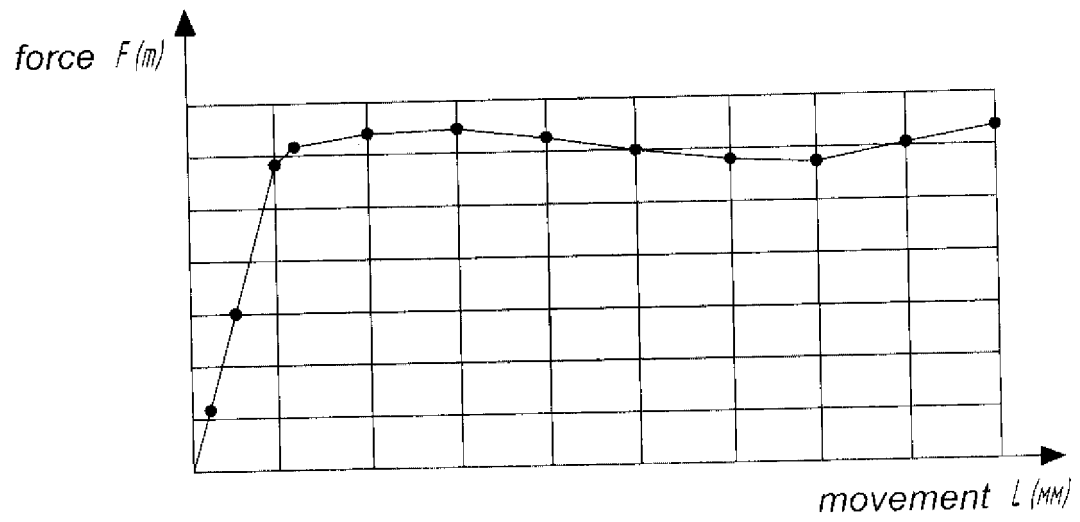


Fig. 15

INTERNATIONAL SEARCH REPORT

International application No.
PCT/RU 2016/000776

A. CLASSIFICATION OF SUBJECT MATTER

E01F 15/00 (2006.01) E01F 15/14 (2006.01)

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)

E01F 15/00, 15/14

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)

PatSearch (RUPTO internal), USPTO, PAJ, Esp@cenet, DWPI, EAPATIS, PATENTSCOPE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 2418325 A2 (SHINDO INDUSTRY CO., LTD) 15.02.2012	1-5
A	US 2005/0084328 A1 (THE TEXAS A&M UNIVERSITY SYSTEM AN AGENCY OF THE STATE OF TEXAS) 21.04.2005	1-5
A	WO 2005/095160 A2 (THE TEXAS A & M UNIVERSITY SYSTEM et al.) 13.10.2005	1-5
A	EP 0474432 A2 (ENERGY ABSORPTION SYSTEMS INC.) 11.03.1992	1-5

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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Date of the actual completion of the international search

07 February 2017 (07.02.2017)

Date of mailing of the international search report

30 March 2017 (30.03.2017)

Name and mailing address of the ISA/

Authorized officer

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Patent documents cited in the description

- RU 2434763 [0002]