(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
30 April 2020 (30.04.2020)

WIPO | PCT

(10) International Publication Number
WO 2020/086032 A1

(51) International Patent Classification:
B60R 19/36 (2006.01)

(21) International Application Number:
PCT/TR2019/050790

(22) International Filing Date:
25 September 2019 (25.09.2019)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2018/15902 24 October 2018 (24.10.2018) TR

(71) Applicant: **ISTANBUL TEKNIK UNIVERSITESI** [TR/TR]; ITU Rektorluk Binasi ITU Ayazaga Kampusu, Maslak, 34469 Istanbul (TR).

(72) Inventors: **GUNAYDIN, Kadir**; Sokubası Mah. No:65 Kat:3 D:7, 51700 Nigde (TR). **TURKMEN, Halit Suleyman**; Itu Maslak Yerleskesi Ucak Ve Uzay Bilimleri Fakultesi Ucak Muhendisligi Bolumu, 34469 Sariyer/Istanbul (TR).

(74) Agent: **CANKAYA PATENT MARKA VE DANISMANLIK LIMITED SIRKETI**; Buklum Sokak 5/16 Kavaklidere, 06680 Ankara (TR).

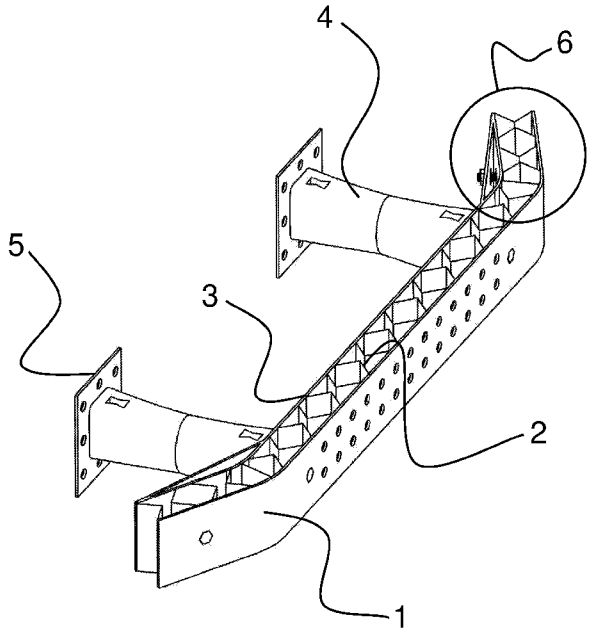
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

WO 2020/086032 A1

(54) Title: AUTOMOBILE CRASH BOX SYSTEM

Figure 1



(57) Abstract: he invention is related to a crash box system comprising "V" shaped leaf springs (2) located between the front plate (1) and the rear plate (3), wherein the leaf springs (2) have been placed vertical to the front plate (1) and rear plate (3) at the wing corners. Moreover, the system subject to the invention is related to a crash box system comprising a cylindrical bevelled tube (8) placed inside the outer tube (4) having an unconventional structure. The "V" shaped leaf springs (2), an outer crash box (outer tube) (4) having an unconventional structure, the re-entrant hexagonal bottom imperfections (12) and the re-entrant hexagonal top imperfections (13), a cylindrical tube (8) and cylindrical tube trigger mechanism (11) provided in the system subject to invention, enables energy absorption such that the peak forces are kept low at different times. By this means it is aimed to prevent, injuries and traumas that occur due to accident effects such as the whiplash effect during accidents at different speeds.

[Continued on next page]

Published:

— *with international search report (Art. 21(3))*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*
— *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

AUTOMOBILE CRASH BOX SYSTEM

Technical Field

The invention is related to a crash box system mounted to the bumper sections of vehicles that has been developed in order to absorb the force created during impact.

The invention is particularly related to a crash box system comprising a rear plate in addition to the crossbar (plate) located in the bumper section of the vehicle, and "V" shaped leaf springs positioned between them and structures where the leaf springs are vertical in relation to the wing inflections of the plates and telescopic unconventional tubular sections.

Prior Art

A conventional vehicle bumper comprises a strong steel crossbar that is fixed to simple structures such as square sectioned or sectional pyramid tubes that are generally fixed to the vehicle structure supporting means, wherein said bumper extends parallel to the front side of the vehicle under the elastic structure observed from the outside. The different shaped tubes which couple this steel crossbar structure to the supporting elements act as the crash absorbing energy and upon this several designs have been developed. In said designs the impact during a crash is initially received by the steel crossbar lying parallel to the vehicle and it submits the force created from the crash to the supporting structure of the vehicle. These tubes are elastically or plastically deformed and they absorb the energy of impact.

A crash box system is formed by mounting onto the front section of the vehicle via parallel steel crossbars, the crash tubes that generally have square sectioned and frusto-conical structures which are coupled to the double-S-guideway which is a part of the chassis of the vehicle.

In present systems the steel crossbar is a rigid structure and therefore it is not able to act as an adequate crash energy absorber. As crash tubes have sharp corners due to their square or rectangular shapes, they cause the formation of stress concentration at the sharp corners when stress is applied thereon. Under such stress, crash boxes (tubes) tear, and as a result of such tearing the crash tubes due not fold and deform which is an important part of crash energy absorption, therefore providing low crash energy absorption. Besides this, these designs have not been conducted according to accidents at different speeds; as a result sometimes said designs are not deformed during small accidents and sometimes they are completely deformed following a high speed accident where the force created from the crash is directly transferred to the passengers inside the cabin.

In the Korean patent document of the prior art numbered KR20100060135A in order to cope with a low speed collision, an integrated assembly of a connecting element such as a crash box and a rear beam is disclosed. In the related document a spring section and a spring connected to the rear beam is disclosed.

In the Korean Patent document numbered KR20110051594 of the prior art, a crash box is described. In the related document it is disclosed that the crash box is coupled to the bumper via a diaphragm spring and leaf spring.

In the United States Patent document numbered US2009243312A1 of the prior art a crash box that is formed of an inner and an outer circular tube is mentioned. (Figure 1) In addition, the document shows a connecting element with a radius at the corners and a circular cavity in the middle. (Figure 9)

In the United States Patent document numbered US2008030031A1 of the known state of the art a crash box that has been developed for vehicles is mentioned. In the related document it has been mentioned that a trigger was present in the vehicle box.

When the present systems in the art have been examined, since the existing solutions do not generally provide different reactions at different speeds, it can be

seen that even at low speeds, due to the high power transmission to the occupants, said solutions may cause injuries and trauma following an accident effect such as the whiplash effect.

Therefore it is required for a crash box system to be developed, comprising “V” shaped leaf springs between two plates, which can be beneficial not only for impacts that are head on but also for impacts received by the vehicle from different angles (at angles remaining between the front of the vehicle and the sides of the vehicle).

Aims of the Invention

The object of the present invention is to develop a crash box system comprising "V" shaped leaf springs between two plates, which includes flat sheets where these leaf springs are perpendicular to the folding points of the plates, and additionally comprises a telescopic outer tube section that does not have a conventional shape.

Another aim of the invention to provide a crash box system which shows different reactions against collisions at different speed, which can absorb impacts not only head on, but from the front-sides, or angularly, by means of the “V” shaped leaf springs located between two steel plates, wings and straight springs at the folding points of the wings.

Detailed Description of the Invention

The system provided in order to reach the aims of the invention has been illustrated in the figures.

According to these figures;

Figure 1: Is the isometric drawing of the crash box system subject to the invention.

Figure 2: Is the top view of the crash box system subject to the invention.

Figure 3: Is the mounted view of the crash boxes in a crash box system subject to the invention.

Figure 4: Is the side section view of the assembly of the crash boxes in a crash box system subject to the invention.

Figure 5: Is the isometric view of the plate assembly in a crash box system subject to the invention.

Figure 6: Is the isometric view of the plate assembly from a different angle, in a crash box system subject to the invention.

The parts in the figures have each been numbered and their references have been listed below.

1. Front plate
2. Leaf springs
3. Rear plate
4. Outer crash box
5. Chassis coupling plate
6. Wing
7. Wing support plate
8. Inner crash box
9. Rectangular section of the outer tube having blended edge corners at the two ends
10. Circular cross section of the outer crash box
11. Trigger mechanism having bevelled inner tube
12. Top re-entrant hexagon imperfection
13. Bottom re-entrant hexagon imperfection
14. Plate insertion holes
15. Straight spring

The invention, is a crash box system, comprising,

- A front plate (1) and a rear plate (3) placed in the bumper section of the vehicle,
- Outer crash box (4) connected to the chassis connection plates (5) from one end and to the rear plate (3) from the other end,
- Inner crash box (8) having a radial structure, located inside the outer crash box (4), and

characterized in that the said system comprising,

- "V" shaped leaf springs placed between the front steel plate (1) and the rear steel plate (3).

In the system according to the invention, the structure forming the beam is the "V" shaped leaf springs placed between the front plate (1) and the rear plate (3), wherein said leaf springs (2) enable the absorption of the impact energy by elastically changing shape during low speed collisions following the deformation of the elastic components belonging to the bumper at the front of the energy absorption system. At the same time, air flow into the hood from the air passage holes (14) located on these plates has been prevented.

The "V" shaped leaf springs (2) of the system subject to the invention have been placed between the front plate and rear plate. The placement of said "V" shaped leaf springs (2) is such that, one end of these springs is placed (welded, coupled by means of hinges) to the front plate (1) and the other end is placed into the channels opened on the rear steel plate (3).

In the system subject to the invention, two wings (6) and straight springs (15) at the folding points of the wings have been provided at the front section of the vehicle for angular collisions. The "V" shaped leaf springs (2) become straight at the folding points of these wings and during an accident; they provide additional energy absorption against head on collisions and angular impact by means of buckling deformation. These wings (6) are supported with extra wing support plates (7) and therefore during impact their flexibility does not increase a lot and as a result they

enable the absorption of accident energy by the leaf springs (2). Following the complete deformation and depletion of the leaf springs (2), the outer crash boxes (4) step in.

Different from the conventional crash boxes, the outer crash boxes (4) comprise rectangles (10) with radius at the start and end sections thereof. The outer crash box (4) with the rectangles having radius at the corner sections includes annular or elliptical transition cross sections (10) in the middle of the outer crash boxes. Therefore, sharp corners that may cause stress concentrations have not been used in boxes.

Outer crash boxes (4) having variable geometry have been used that are coupled from one end to the present chassis connection plates (5) and from the other end to the steel rear plate (3), in order to couple the system subject to the invention to the chassis of the vehicle.

At the starting rectangular sections, re-entrant hexagonal top and bottom imperfections (12, 13) have been formed on the box. Rectangular sections (9) have been used in order to simplify the mounting section. The re-entrant hexagonal top and bottom imperfections (12, 13) on the tubes, have been designed such that the tubes fold from both ends and absorb impact energy without increasing peak force, during collisions at higher speeds which enable the deformation of the leaf springs. The reason for the middle section of the tubes to be annular or elliptical (9) is that circular geometries are superior in absorbing impact energy in comparison to other geometries.

Even after the folding of the tubes (9) at both ends due to the force created during an accident, the annular sections (10) will also be deformed and shall absorb impact energy. Following the deformation and almost depletion of the outer box (4), in order to prevent the transmission of impact force completely into the cabin, an inner crash box (8) has been used. The bevelled trigger mechanism (11) of the inner crash box (8) ensures that the peak force is low and reduces whiplash effect.

By means of the rigid leaf springs (2) subject to the invention the vehicle will not be damaged at all or shall be damaged less than it normally would, due to the elastic deformation of said leaf springs (2) even at very low speed. Situations such as injuries, trauma and death shall be prevented by means of accident energy absorption even at high speeds, without tearing but folding of the outer crash boxes (4) of accident energy absorbing system. Following collisions with high energy that may completely deplete the outer crash boxes (4), the inner crash box (8) shall step in and shall absorb impact energy by means of plastic deformation. As the inner crash box (8) has a bevelled trigger mechanism (11) this shall also prevent high peak forces.

CLAIMS

1. The invention, is a crash box system, characterized by comprising,

- A front plate (1) and a rear plate (3) placed in the front bumper section of the vehicle,
- Outer crash box (4) connected to the chassis connection plates (5) from one end and to the rear plate (3) from the other end,
- Inner crash box (8) having a cylindrical structure, located inside the outer crash box (4),

characterized in that the said system comprising,

- "V" shaped leaf springs (2) placed between the front plate (1) and the rear plate (3).

2. A system according to claim 1, characterized in that the "V" shaped leaf springs have been placed vertically, between the front plate (1) and the rear plate (3).

3. A system according to claim 2, characterized by comprising wings (6) formed by folding of the ends of the front plate (1) and the rear plate (3).

4. A system according to claim 3, characterized in that the inner crash box (8) comprises a bevelled trigger mechanism (11).

5. A system according to claim 4, characterized in that it comprises re-entrant hexagonal bottom imperfections (12) and re-entrant hexagonal top imperfections (13) on the crash box.

6. A system according to claim 5, characterized in that the wings (6) comprise straight springs (15) at the folding points.

Figure 1

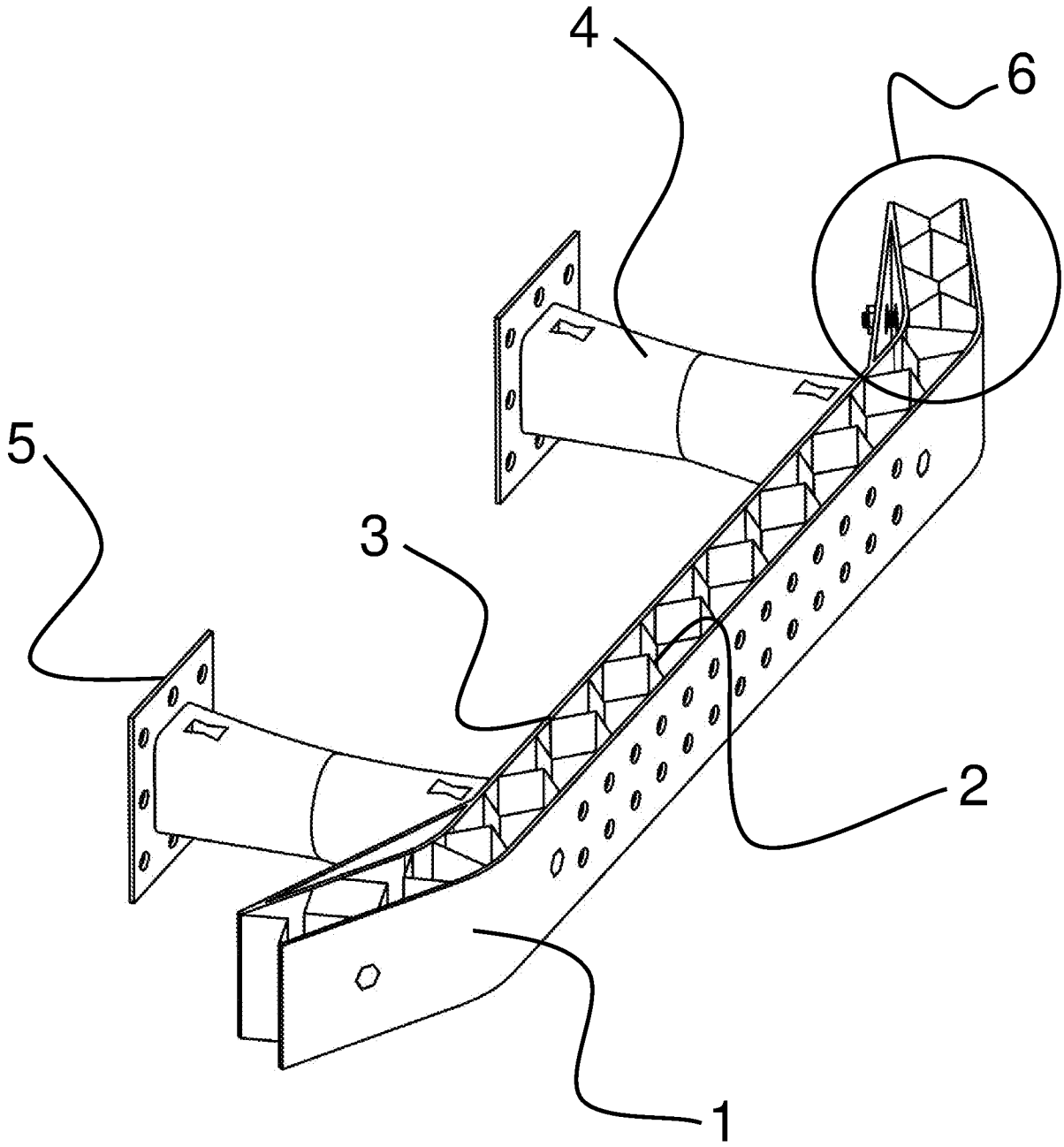


Figure 2

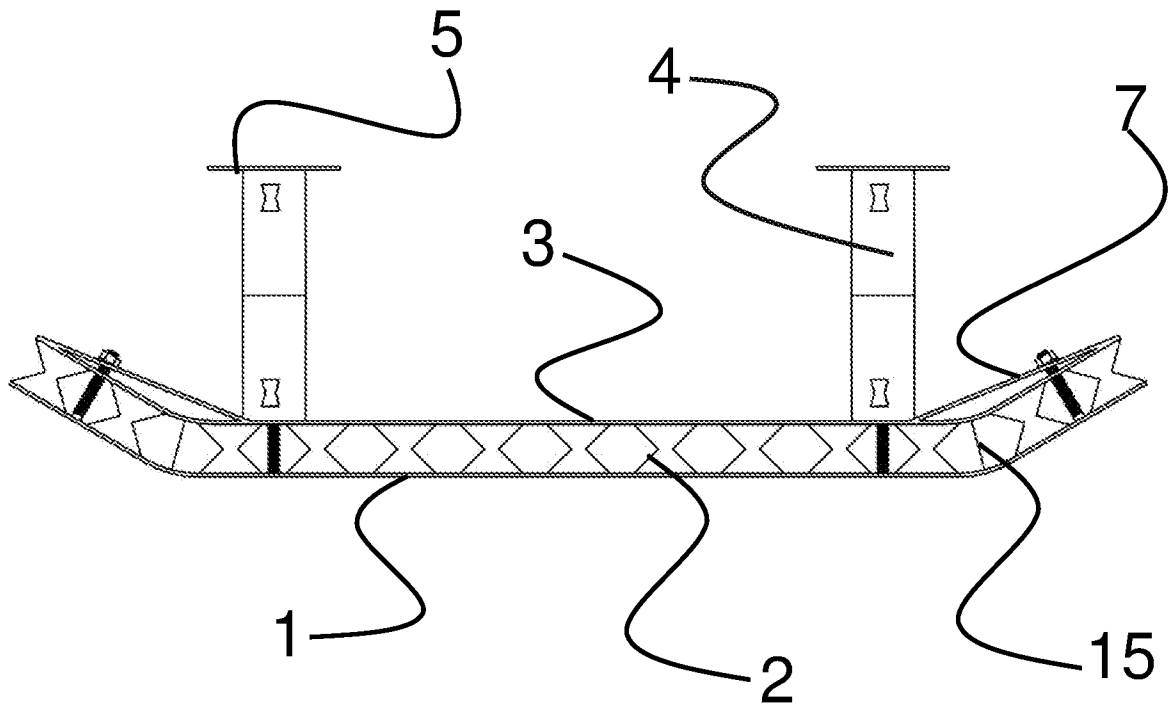


Figure 3

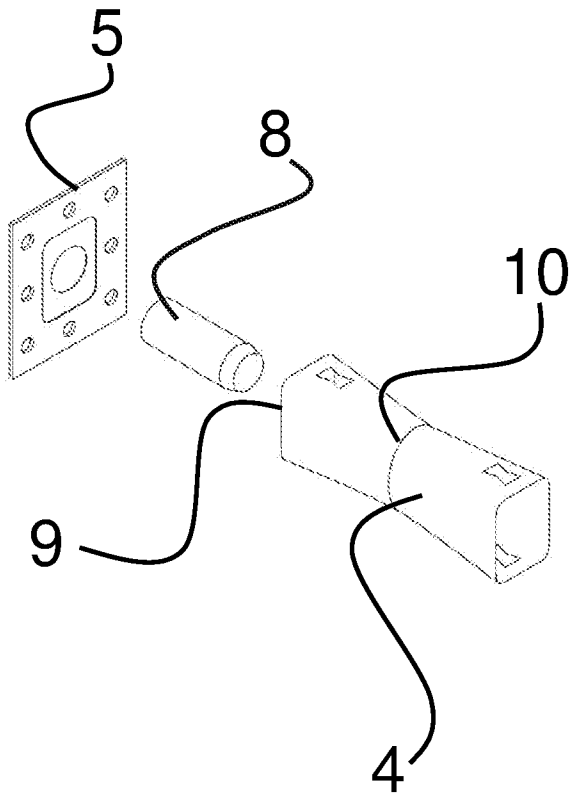


Figure 4

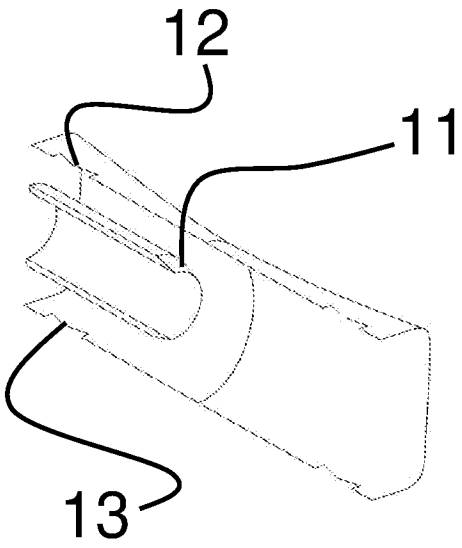


Figure 5

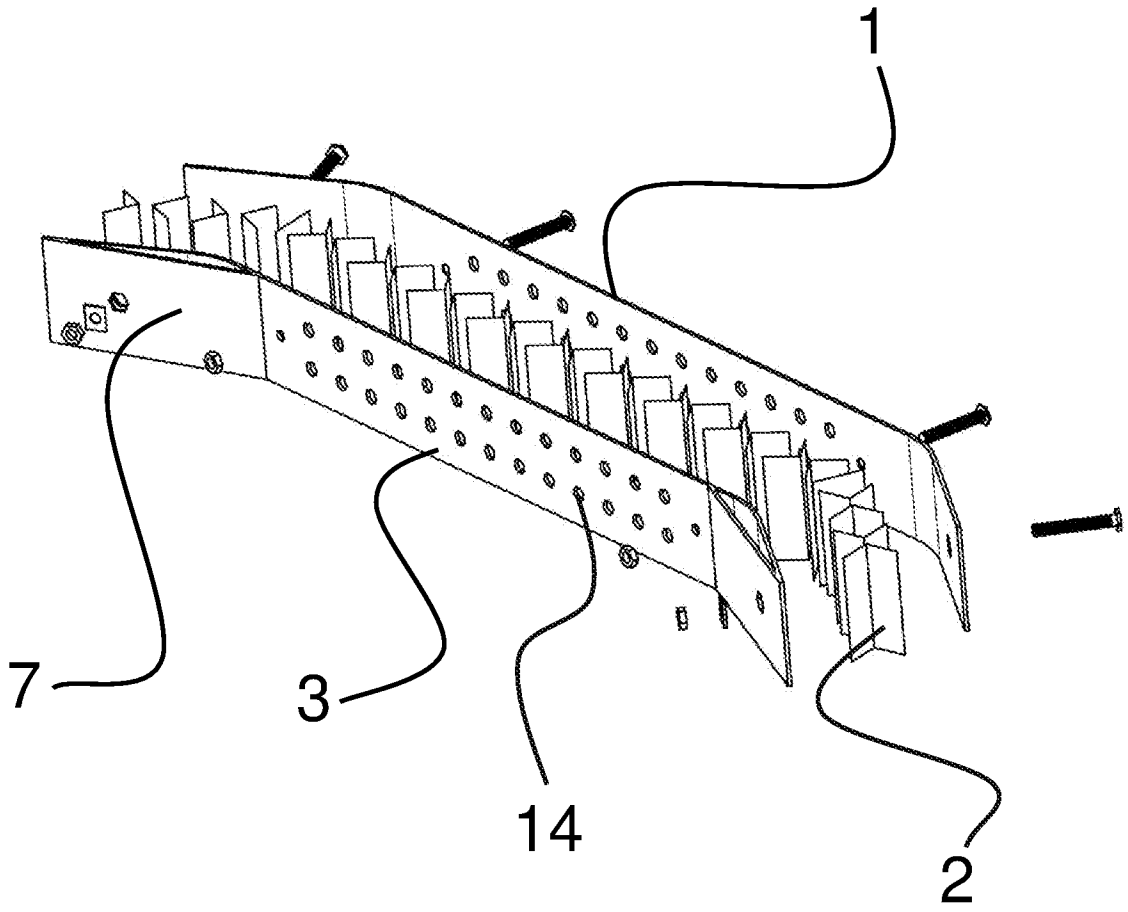
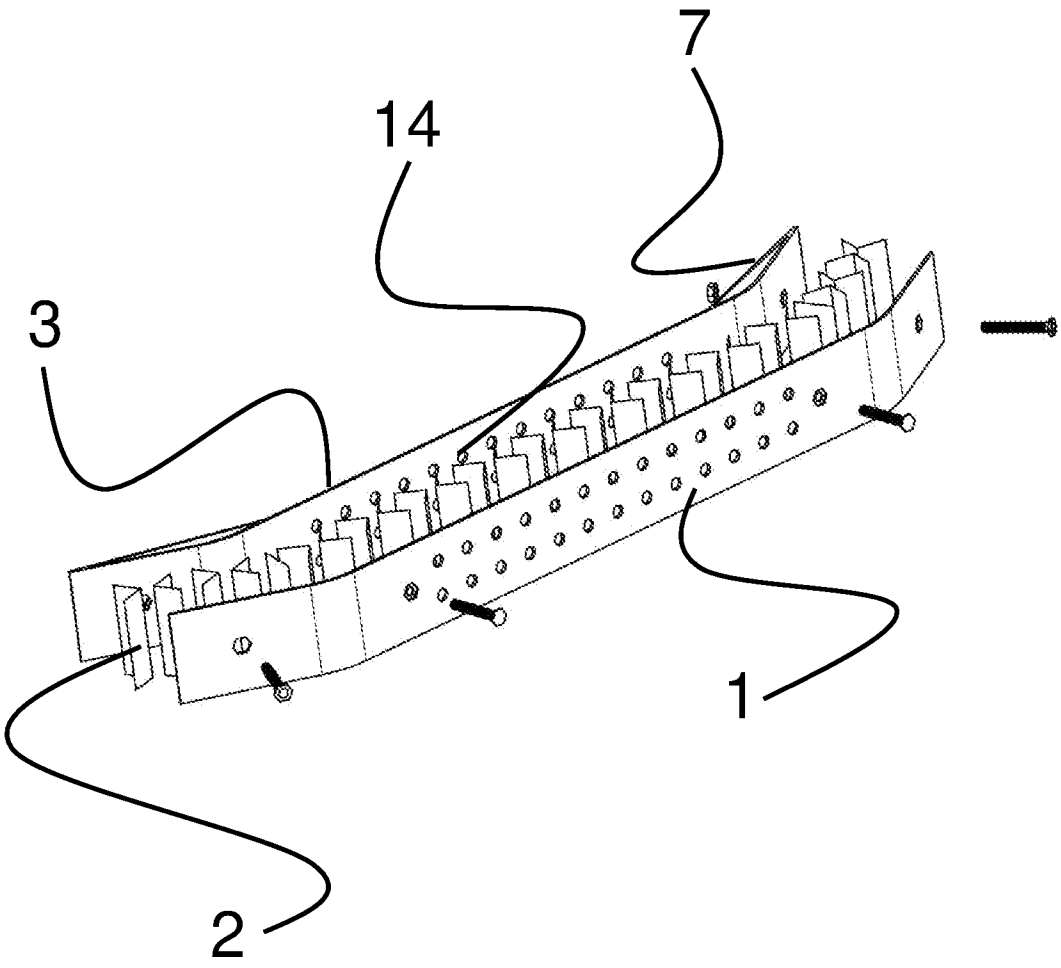


Figure 6



INTERNATIONAL SEARCH REPORT

International application No.
PCT/TR2019/050790

A. CLASSIFICATION OF SUBJECT MATTER

B60R 19/36 (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)

B60R 19/36

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 106240505 A (SUZHOU WANLONG AUTO PARTS CO) 21 December 2016 (2016-12-21) Especially Figure 1	1-6
Y	KR 20110032870 A (POSCO [KR]) 30 March 2011 (2011-03-30) figures	1,4
Y	EP 2937249 A1 (TOYOTA MOTOR CO LTD [JP]) 28 October 2015 (2015-10-28) figures	5
Y	WO 2005120903 A1 (GESTAMP HARDTECH AB [SE]) 22 December 2005 (2005-12-22) entire document	5
A	US 2017106822 A1 (STEINEBACH EDWARD K [US]) 20 April 2017 (2017-04-20) whole document	1-6
A	WO 2018119255 A1 (MAGNA INT INC [CA]) 28 June 2018 (2018-06-28) whole document	1-6
A	WO 2016007661 A1 (MAGNA INT INC [CA]) 14 January 2016 (2016-01-14) whole document	1-6

☑ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"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
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
03 April 2020	**03 April 2020**

Name and mailing address of the ISA/TR	Authorized officer
Turkish Patent and Trademark Office (Turkpatent) **Hipodrom Caddesi No. 13** **06560 Yenimahalle** **Ankara** **Turkey** Telephone No. **(90-312) 303 11 82** Facsimile No. **+903123031220**	**Veysel Murat ÖNAL** Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/TR2019/050790

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2018037179 A1 (STEINEBACH EDWARD KARL [US]) 08 February 2018 (2018-02-08) whole document	1-6