



- (51) **International Patent Classification:**
E01F 15/04 (2006.01) *E01D 19/10* (2006.01)
- (21) **International Application Number:**
PCT/EP2013/001313
- (22) **International Filing Date:**
3 May 2013 (03.05.2013)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
12003229.7 3 May 2012 (03.05.2012) EP
- (71) **Applicant:** TATA STEEL UK LIMITED [GB/GB]; 30 Millbank, London SW1P 4WY (GB).
- (72) **Inventors:** SIRMAN, Steven Charles; Tata Steel Nederland Technology B.V., Group Intellectual Property Services - 3G.37, Wenckebachstraat 1, NL-1951 JZ Velsen-Noord (NL). BLOWEY, Andrew Thomas; Tata Steel Nederland Technology B.V., Group Intellectual Property Services - 3G.37, Wenckebachstraat 1, NL-1951 JZ Velsen-Noord (NL). MUSTARD, Trevor Raymond; Tata Steel Nederland Technology B.V., Group Intellectual Property Services - 3G.37, Wenckebachstraat 1, NL-1951 JZ Velsen-Noord (NL).
- (74) **Agent:** BLAUW, Frans Gerard; Tata Steel Nederland Technology B.V., Group Intellectual Property Services - 3G.37, P.O. Box 10000, NL-1970 CA IJmuiden (NL).

(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, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, 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, 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, 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, ML, MR, NE, SN, TD, TG).

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))

(54) **Title:** SAFETY FENCE AND POST FOR SAFETY FENCE

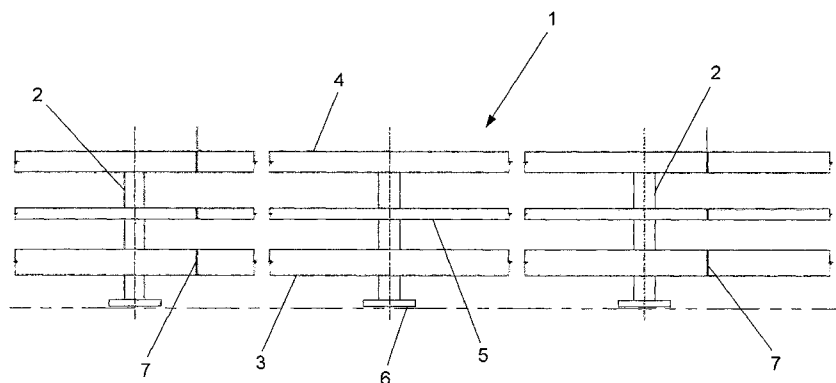


Fig. 1

(57) **Abstract:** The invention relates to a safety fence or parapet (1) and associated post (2) that meet the requirements for maximum load and maximum deflection angle associated with the highest level of containment. To that end the invention provides a safety fence comprising posts and one or more rails (3,4,5) attached to the posts, wherein the top of one or more of the posts is chamfered (12) opposite of the part of the post to which one or more rails are fastened.

SAFETY FENCE AND POST FOR SAFETY FENCE

Field of the invention

The invention relates to a safety fence and post for a safety fence, more in particular a highway safety fence and post for safety fence which in combination provide a high containment level. The general term safety fence includes parapet and associated post for use on bridges and like structures.

Background of the invention

The standards for highway safety fences have been increased over the years for several reasons among which are the increase of traffic and the increase of the weight of most cars, busses and lorries. Moreover, the safety fences that have been accredited to the safety standards in the past have proven to not always provide the protection that is expected.

The terms "safety fence" and "parapet" are used interchangeably in the description unless specifically restricted to one of these terms.

When existing safety fences need to be replaced because the end of lifetime is reached, this implies that these in many cases can not simply be replaced by the same safety fence or parapet again because more severe safety standards apply at present then when safety fence or parapet that have to be replaced were originally placed.

In a significant number of cases, there is a space restriction for the installation of safety fences and bridge parapet, requiring the deflection of the safety fence or parapet to be limited within certain bounds during an impact with an errant vehicle. This deflection is known as 'Working Width' in the standard. In the case of a bridge, the vehicle must be prevented from going beyond the edge of the bridge. If a bridge has part of its construction protruding above the road surface, such as support towers, these also have to be guarded by means of safety fences.

With increased safety standards this will mean in most cases that when the old safety fence has to be replaced by a new more sturdier safety fence that the new safety fence should not take up more space than the old safety fence. At the same time the new safety fence should preferably be designed such that the mounting points of the previous safety fence can be used without having to make additional mounting points. Another important point is, especially near constructions like for instance support towers, that the deflection of the safety fence with a vehicle crashing into the safety fence stays within certain limits. Moreover, the new safety

fence should preferably not have an increased wind loading compared to that of the old safety fence.

Objectives of the invention

5 It is therefore an objective of the present invention to provide a safety fence with a predetermined level of containment.

 It is another objective of the present invention to provide a safety fence with a limited deflection of the safety fence when a vehicle crashes into the safety fence which allows for a close spacing of the safety fence with respect to constructions
10 protected by the safety fence.

 It is another objective of the present invention to provide a safety fence with a limited cross section seen in a direction perpendicular to the length direction of the safety fence.

 It is another objective of the present invention to provide a safety fence with a
15 low safety fence post capacity to reduce loading transferred to the construction to which it is attached.

 It is another objective of the present invention to provide a safety fence with an increased post spacing to be able to replace existing safety fence with a less high containment level.

20 It is still another objective of the present invention to provide a safety fence with an open construction to minimise wind loading.

Description of the invention

 According to a first aspect of the invention one or more of the objectives of
25 the invention are realized by providing a safety fence comprising posts and one or more rails attached to the posts, wherein the top of one or more of the posts is provided with a chamfer and wherein the chamfer runs in downward direction away from the rails as seen with safety fence and posts in situ.

 The safety fence according to the invention is designed to comply with the
30 H4a containment level, a UK standard that corresponds to European EN1317 Test TB71 requirements. This implies that the safety fence should be capable of absorbing the load of a 30 ton heavy goods vehicle crashing into the safety fence at a speed of 65km/h. With such a crash the safety fence will deflect from the original position which might easily result in that part of the safety fence and more in
35 particular a number of posts will deflect beyond the deflection limit that is required for particular applications.

The invention is based on the insight that with this measure a safety fence can be realized that not only fulfils this specific requirement of staying within the deflection limit associated with a certain containment level but that at the same time a safety fence can be provided that it is capable of sufficiently absorbing the crash energy. This last feature is important because otherwise a vehicle crashing into the safety fence could bounce directly off to the road and into traffic which could result in even more damage and personal injuries.

According to a further aspect it is provided that the top of the post for the safety fence is chamfered at an angle between 30° - 60° , more preferably at an angle between 40° - 50° . Such a chamfer is very effective since it could result in a deflection that is considerably less and may even result in a deflection that is up to 15% less than would be the case with a safety fence without such chamfer. As a result there is more room to better adapt the safety fence to absorb the load of a crash.

In order to realize that the crash energy is absorbed it is provided that at least one of the rails connects to a post for the safety fence by means of a bracket designed to absorb at least part of the load of a vehicle crashing into the safety fence. To that end it is further provided that the bracket at opposite ends is respectively fastened to post and rail and wherein the bracket has a bend. Such a bend includes a smoothly curved part as well as a part with a sharp bend or kink. With such a bracket it is possible to tune the bracket to a certain crash load.

According to a further aspect it is provided that the bracket has two parts running from post to the rail, which parts are bent in opposite direction, preferably in a direction away from each other. By bending the parts in a direction away from each other these parts are not likely to butt against each other with deformation of the bracket and therewith change the deformation characteristics of the bracket. A bracket with two such bent parts can be fine tuned easier and with greater reliability.

According to a further elaboration the bracket has two parallel sides which are respectively fastened to the post and the rail and which connect to the bent connecting parts. A rectangular section can be used to make such a bracket by bending two opposite sides in outward direction while the other two opposite sides are used to fasten the bracket to respectively post and rail.

The post for the safety fence comprises a U-section or a hollow section, wherein the hollow section could be a round hollow section or a rectangular hollow

section, including a square hollow section. Because of sturdiness the hollow sections are preferred.

The post for the safety fence is fastened to a base plate at a position offset from the centre line of the base plate that runs parallel to the length direction of the rail with the largest part of the base plate at the side of the one or more rails. The
5 base plate is secured to the substrate, for instance bolted to a concrete substrate, and the post is for instance welded to the base plate. With the dimensions of the base plate as set out above the base plate will remain fixed to the substrate with a crash at the H4a containment level and the post will remain fixed to the base plate.
10 The post will deflect from the original line by bending of the post at a level directly above the base plate.

The rail that is fastened to the bracket extends in a direction perpendicular to the length direction of the rail to beyond the base plate. The parapet post is fixed to a substrate that in most cases will be of a different material from the substrate of
15 the road itself, for instance concrete versus hot-rolled asphalt, which may extend above the level of the surface of the road. The rail extends to beyond the base plate and preferably up to or beyond the transition between the substrate of the post for the safety fence and the surface of the road if these are at different levels.

According to a further aspect a rail is provided at the top of the post which has
20 a maximum extension in a direction perpendicular to the length direction of the rail that does not extend beyond the bracket seen in vertical direction. This rail is fastened against the post without a bracket since the impact of smaller vehicles crashing into the parapet will be below this level of the post. It has proven that with the chamfer of the top of the post as explained above that the strength of the post
25 at this level is not affected or hardly not affected.

According to still a further aspect a third rail is provided between the rail fastened to the bracket and the rail at the top of the post which has a maximum extension in a direction perpendicular to the length direction of the rail that does not extend beyond the bracket seen in vertical direction. Preferably the dimension of
30 the third rail seen in vertical direction is less than the dimension in horizontal direction. This will result in that the safety fence or parapet will be less susceptible to wind load.

The invention further includes a post for a safety fence or parapet with one or more rails comprising a U-section or a hollow section fastened to a base plate,
35 wherein the top of the post is provided with a chamfer and wherein the chamfer

runs in downward direction away from the side to which one or more rails are to be fastened.

According to a further aspect the top of the post is chamfered at an angle between 30° - 60°, more preferably at an angle between 40° - 50°.

- 5 According to still a further aspect it is provided that the post is fastened to a base plate at a position off centre of the base plate with the largest extension of the base plate at the side of the post facing away from the chamfered part of the post.

Brief description of the drawings

- 10 The invention will be further explained on hand of the example shown in the drawing, in which:

Fig.1 shows a front view of the safety fence from the side of the traffic;

Fig.2 shows a section through safety fence and post for safety fence;

Fig.3 shows a section through bottom rail, bracket and post, and

- 15 Fig.4 shows a section through a further rail and post.

Detailed description of the drawings

- In fig.1 a safety fence or parapet 1 is shown with posts 2, a lower rail 3, a top rail 4 and an intermediate rail 5. The posts 2 are fixed to a base plate 6 which in turn is fixed to the substrate, for instance a concrete substrate of a bridge. The rails 3, 4 and 5 are put together from length units that are connected by joints 7, preferably bolted joints. The length units of rail and the distance between the posts are taken such that the joints 7 are always at a distance from the posts 2 in order to prevent that the joints 7 coincide with the fastening points between the rails and the posts 2.
- 20 posts 2.

Fig.2 shows a section through safety fence 1 with post 2, rails 3, 4, 5, base plate 6, substrate 8 for base plate 6 and part of the road 9 adjacent substrate 8.

- The lower most rail 3 is fastened to a bracket 10 which in its turn is fastened to post 2. The rail 3 has a rectangular shape in cross section with the longest sides running in vertical direction. The side of rail 3 facing away from the post 2 extends beyond base plate 6 and in this example also lies just beyond the boundary between substrate 8 for base plate 6 and the road 9. Although said outer side of rail 3 could be situated even further beyond said boundary between substrate 8 for base plate 6 and the road that is preferably avoided because it would mean unnecessary use of space. The base plate 6 is fastened by means of bolts 11 to substrate 8.
- 30 running in vertical direction. The side of rail 3 facing away from the post 2 extends beyond base plate 6 and in this example also lies just beyond the boundary between substrate 8 for base plate 6 and the road 9. Although said outer side of rail 3 could be situated even further beyond said boundary between substrate 8 for base plate 6 and the road that is preferably avoided because it would mean unnecessary use of space. The base plate 6 is fastened by means of bolts 11 to substrate 8.
- 35 unnecessary use of space. The base plate 6 is fastened by means of bolts 11 to substrate 8.

The top rail 4 and the intermediate rail 5 extend over the same length in horizontal direction perpendicular to the length of the rail, which is less than the length of bracket 10 in that direction. This leaves enough space for deformation of bracket 10 before a vehicle crashing into the safety fence or parapet also hits the other rails 4, 5.

At the top post 2 has a chamfer 12 at an angle between 30° - 60° with the side to the which the rails 3, 4, 5 are fastened. In the figure the angle is about 45° . Although the top rail 4 is fastened to the chamfered top part of post 2 that does not weaken the construction of the parapet at this point as the majority of the load sustained by the post is at its base. Typical dimensions for rail 4, the top rail, are in the range of $(180-220\text{mm}) \times (180-220\text{mm})$, for rail 5, the mid rail, $(180-220) \times (100-120)\text{mm}$ and for rail 3, the bottom rail, $(220-260) \times (120-180)$. The thickness for these rails is in the range of 5-8mm. In practice a good combination is 200x200x6.3mm for top rail 4, 200x100x6.3mm for the mid rail 5 and 250x150x5mm for bottom rail 4. Another option is to have three identical rails of for instance 250x150x5mm for all rails.

The height of post 2 in the figure is about 1.50m, the post is made from a 18x18cm hollow section and the chamfer has an angle of about 45° . This means that the total deflection of a post bend because of a vehicle crashing into the safety fence or parapet is considerably less than with a post without chamfer. For example a 1.50m tall post leaning over to 45° would result in approximately a 125mm reduction in deflection from 1060mm to 935mm.

The dimensions for post 2 could be in the range of $(140-200) \times (140-200)\text{mm}$ with a thickness in the range of 5-8mm. The post can be made of a square or rectangular section or of a U-section.

Fig.3 shows a section through bottom rail 3, bracket 10 and post 2. Bracket 10 is bolted at opposite sides 13, 14 to respectively post 2 and rail 3. Opposite sides 15, 16 of bracket 10 have a bend resulting in that the sides 13, 14 and the straight parts of bent sides 15, 16 are at an angle of between 115° - 125° . In the present example the angle is somewhere in the range of 118° - 120° . With such an angle and both sides bent in outward direction the load of a crash can be absorbed in a controlled manner.

Fig.4 shows a section through rail 5 and post 2. A mounting plate 17 is fastened to the post 2 for instance by welding mounting plate 17 to post 2. The top rail 4 is fastened in the same manner to post 2. By providing slots in the mounting

- 7 -

plate and/or in the rail there will be enough play to be able to fasten the rails without difficulty to the post.

CLAIMS

1. Safety fence comprising posts and one or more rails attached to the posts, wherein the top of one or more of the posts is provided with a chamfer and
5 wherein the chamfer runs in downward direction away from the rails as seen with safety fence and posts in situ and wherein the top of the post is chamfered at an angle between 30° - 60°.
2. Safety fence according to claim 1, wherein the top of the post is chamfered at
10 an angle between 40° - 50°.
3. Safety fence according to claim 1 or 2, wherein at least one of the rails connects to a post by means of a bracket designed to absorb at least part of the load of a vehicle crashing into the safety fence.
15
4. Safety fence according to claim 3, wherein the bracket at opposite ends is respectively fastened to post and rail and wherein the bracket has a bend.
5. Safety fence according to claim 4, wherein the bracket has two parts running
20 from post to the rail, which parts are bent in opposite direction, preferably in a direction away from each other.
6. Safety fence according to claim 5, wherein the bracket has two parallel sides which are respectively fastened to the post and the rail and which connect to
25 the bend connecting parts.
7. Safety fence according to one or more of claims 1-6, wherein the post comprises a U-section or a hollow section.
- 30 8. Safety fence according to one or more of claims 1-7, wherein the post is fastened to a base plate at a position offset from the centre line of the base plate that runs parallel to the length direction of the rail with the largest part of the base plate at the side of the one or more rails.

9. Safety fence according to claim 8, wherein the rail which is fastened to the bracket extends in a direction perpendicular to the length direction of the rail to beyond the base plate.
- 5 10. Safety fence according to one or more of claims 1-9, wherein a rail is provided at the top of the post which has a maximum extension in a direction perpendicular to the length direction of the rail that does not extend beyond the bracket seen in vertical direction.
- 10 11. Safety fence according to claim 9, wherein a third rail is provided between the rail fastened to the bracket and the rail at the top of the post which has a maximum extension in a direction perpendicular to the length direction of the rail that does not extend beyond the bracket seen in vertical direction.
- 15 12. Safety fence according to claim 12, wherein the dimension of the third rail seen in vertical direction is less than the dimension in horizontal direction.
13. Post for a safety fence with one or more rails comprising a U-section or a hollow section fastened to a base plate, wherein the top of the post is provided with a chamfer and wherein the chamfer runs in downward direction
20 away from the side to which one or more rails are to be fastened and wherein the top of the post is chamfered at an angle between 30° - 60°.
14. Post according to claim 13, wherein the top of the post is chamfered at an
25 angle between 40° - 50°.
15. Post according to claim 13 or 14, wherein the post is fastened to a base plate at a position off centre of the base plate with the largest extension of the base plate at the side of the post facing away from the chamfered part of the post.

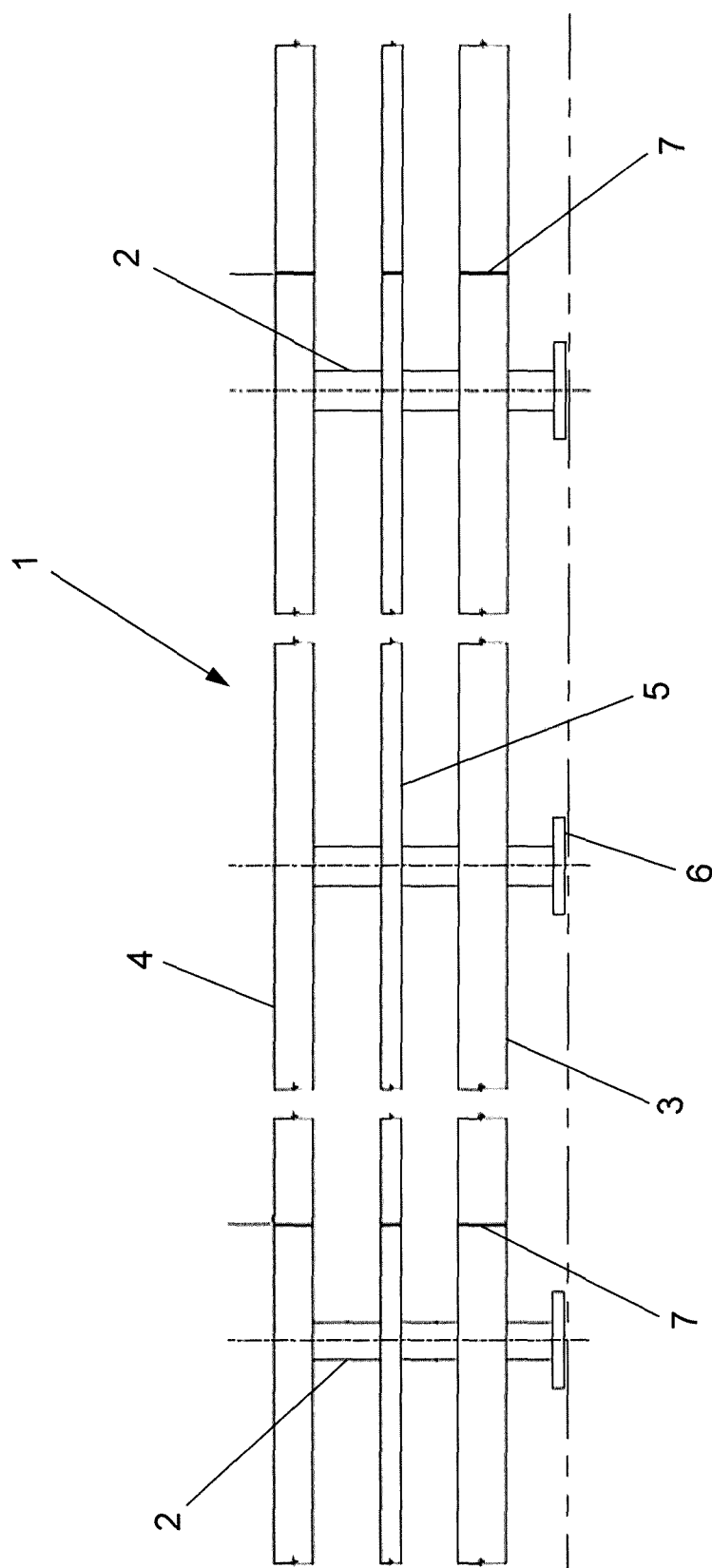


Fig. 1

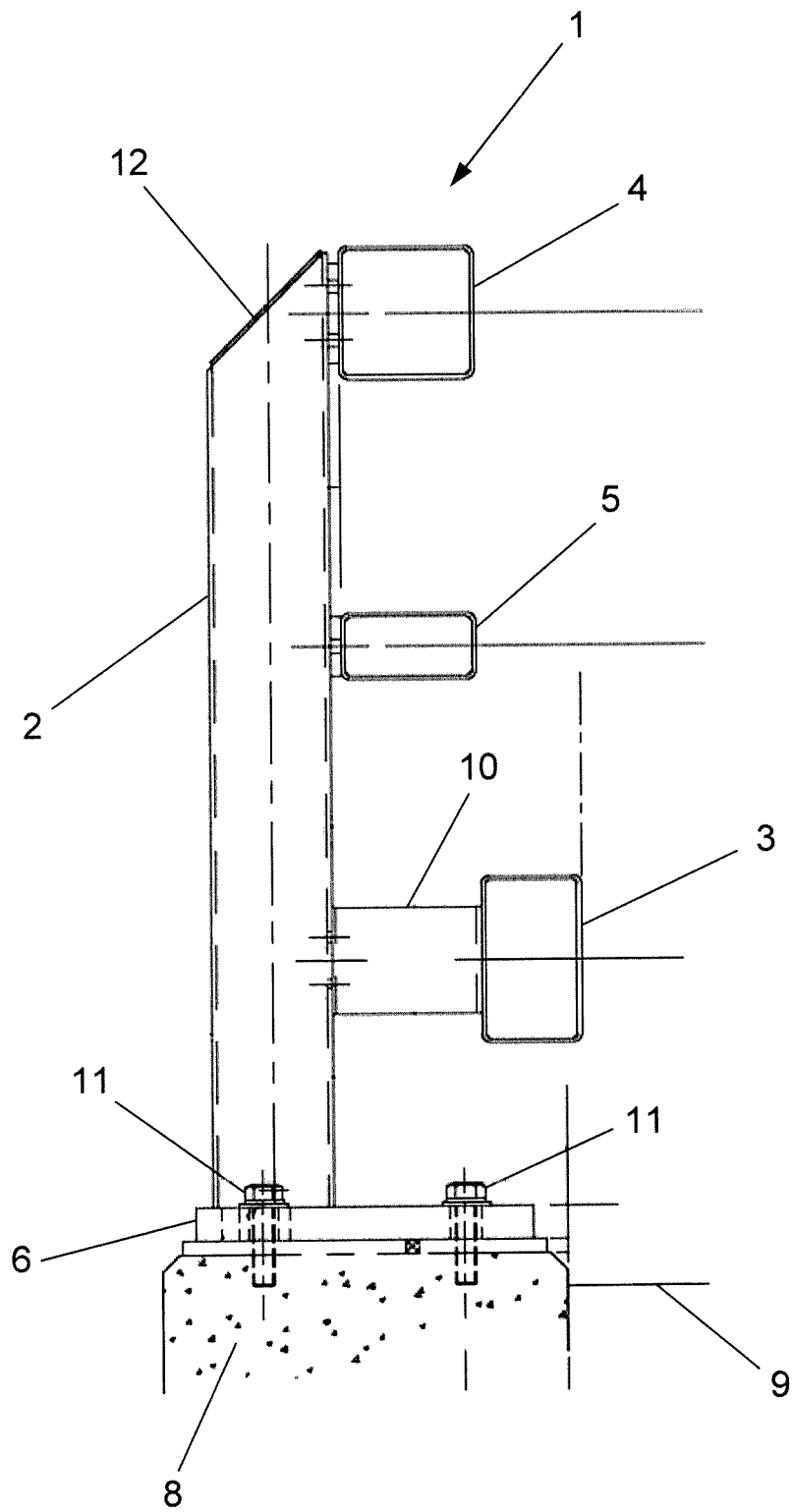


Fig. 2

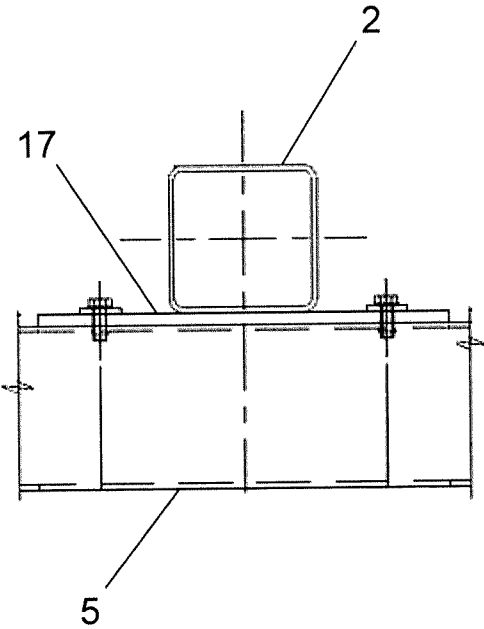


Fig. 4

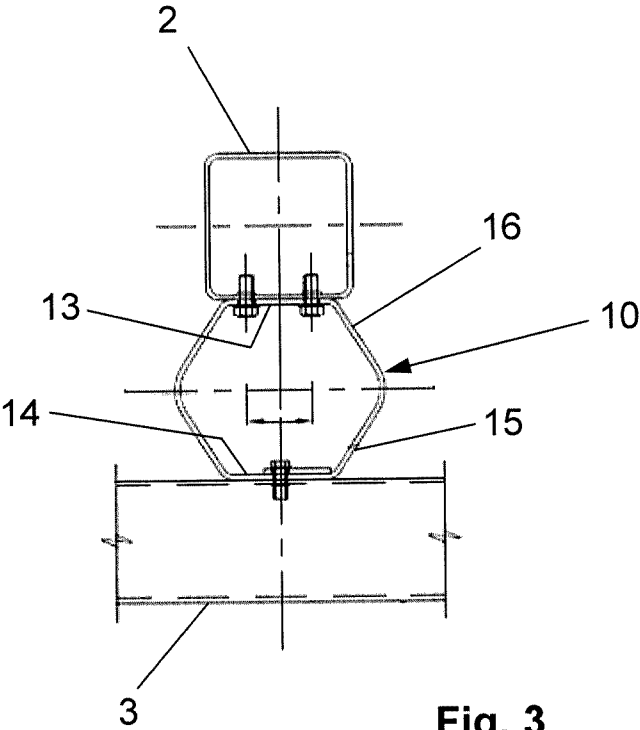


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2013/001313

A. CLASSIFICATION OF SUBJECT MATTER
 INV. E01F15/04 E01D19/10
 ADD.

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 E01D

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2 733 897 A (DIAMOND HARRY [US]) 7 February 1956 (1956-02-07)	1,2,13, 14
Y	the whole document	3-6, 8-12,15
Y	----- ES 2 325 670 A1 (FERROVIAL AGROMAN S A [ES]) 11 September 2009 (2009-09-11) figures 1-6	3-6, 8-12,15
X	----- CH 416 713 A (CLOTURA S A [CH]) 15 July 1966 (1966-07-15) page 1, lines 41-47; figure 1	1,2
X	----- US 5 720 470 A (JOHANSSON JERZY KRYSZOF [SE]) 24 February 1998 (1998-02-24) column 2, line 35 - column 3, line 27; figures 1-5	1-4,7
	----- -/-	



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

20 August 2013

Date of mailing of the international search report

29/08/2013

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
 NL - 2280 HV Rijswijk
 Tel. (+31-70) 340-2040,
 Fax: (+31-70) 340-3016

Authorized officer

Flores Hokkanen, P

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2013/001313

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1 813 726 A1 (CORUS UK LTD [GB]) 1 August 2007 (2007-08-01) paragraphs [0019], [0020], [0028]; figures 1-3b -----	3-6
A	DE 202 10 515 U1 (WOHLFARTH LOTHAR [DE]) 5 September 2002 (2002-09-05) page 8, lines 23-29; figure 5 -----	8,15
A	EP 1 918 460 A1 (HIERROS Y APLANACIONES S A HIA [ES]) 7 May 2008 (2008-05-07) abstract; figure 3 -----	9-12

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2013/001313

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2733897	A	07-02-1956	NONE
ES 2325670	A1	11-09-2009	NONE
CH 416713	A	15-07-1966	NONE
US 5720470	A	24-02-1998	SE 507835 C2 20-07-1998 SE 9601182 A 28-09-1997 US 5720470 A 24-02-1998
EP 1813726	A1	01-08-2007	EP 1813726 A1 01-08-2007 GB 2439318 A 27-12-2007
DE 20210515	U1	05-09-2002	NONE
EP 1918460	A1	07-05-2008	AT 488643 T 15-12-2010 DK 1918460 T3 07-03-2011 EP 1918460 A1 07-05-2008 PT 1918460 E 22-02-2011 SI 1918460 T1 29-04-2011 WO 2008053054 A1 08-05-2008