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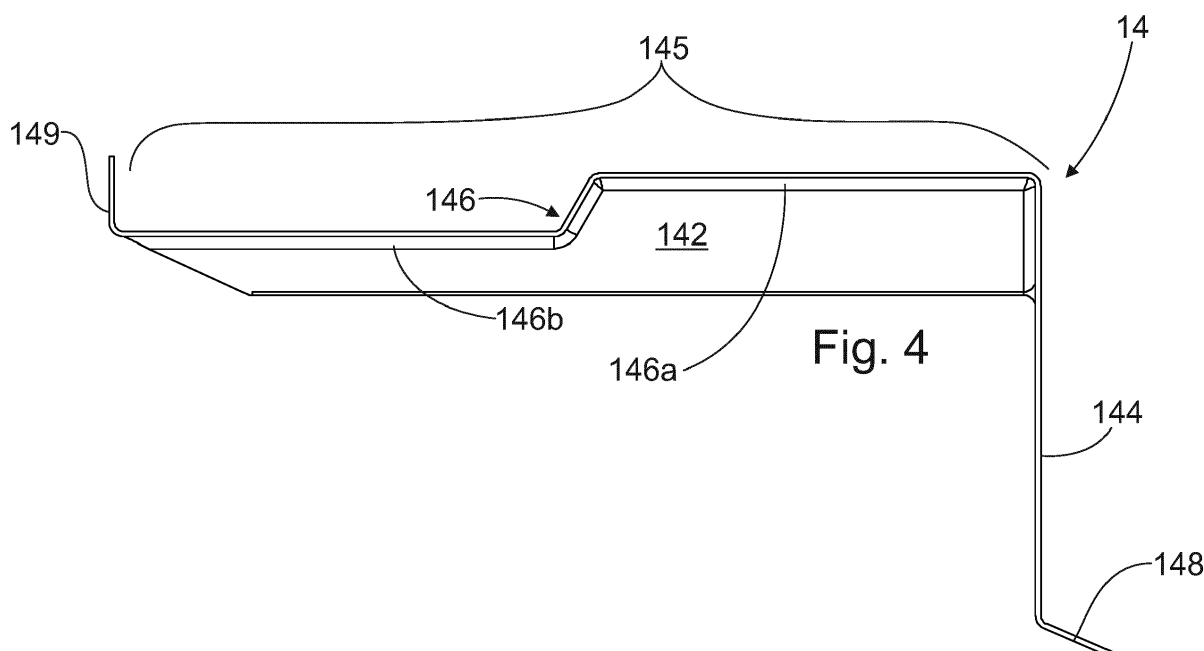
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(54) **BLEACHERS**

(57) The invention relates to lightweight bleachers (10) that are able to be assembled and dismantled.

The bleachers (10) comprise rack elements (14) bound to each other front and back, each of which comprises,  
- a sheet-metal structure, in the profile of which is at least a vertical wall (144) as a flanged structure (144) and a horizontal portion (145) relative to it, and in it a seat portion (146a), to which the seats (12) are attached, and the foot space (146b) of a higher row of seats,  
- the rack elements (14) are attached to pedestal structures (40) at both ends of the rack element (14) and that

- the attachment takes place to an obliquely downwards running support beam (16) of the pedestal structure (40),  
- a longitudinal flanged strip (146) between the seat portion (146a) and the foot space (146b) in the horizontal portion (145) of the rack element (14), i.e. the seat portion (146a),  
- the upper and/or lower edge of the rack element (14) includes a flanged edge strip (148, 149) in order to stiffen the structure.



**Fig. 4**

## Description

**[0001]** The invention relates to bleachers, which are a metal structure and preferably of aluminium. In particular the invention relates to bleachers that can be re-erected and dismantled.

**[0002]** Known bleacher structures are difficult to re-erect. The structures are too heavy and comprise many different components, so that the dismantling and re-erection of the structure takes time. The structures are also expensive.

**[0003]** Patent publications WO 2018/215670A1, US 2,171,374 A, and US 2297101 A disclose a rack element, which is formed from flanged plate and supported at its ends on pedestal structures and particularly on slanting support beams. In the rack element there is primarily a horizontal portion and joined to it a downwardly flanged vertical wall, as well as at either end of the cross-sectional profile a flanged edge strip to stiffen the structure. The horizontal portion comprises a foot space for the upper tier and it carries a row of seats on its front part.

**[0004]** In order to create a load-bearing capacity according to regulations, the rack elements must be made from significantly thick material, or the span must be reduced.

**[0005]** The present invention is intended to bring a new type of bleacher, by which the aforementioned drawbacks can be avoided. The bleachers according to the invention are characterized by what is stated in the Claims.

**[0006]** The bleachers according to the invention are formed of rack elements, which are attached to the support structure's obliquely downwards running upper beams. At least the rack element is of aluminium. The support structures, i.e. the pedestal structure at both ends of the rack element, are preferably lattice girder structures, which are supported on the ground from the vertical beams.

**[0007]** The rack element forms, in its profile, both a seat part and a foot space and acts, in addition, to stiffen the structure. It is the structure's most important component with several flangings. It is attached rigidly to the next rack elements above and below the element in question both through an attachment plate, i.e. angle support, to a support structure such as a lattice girder structure, to its uppermost downwardly obliquely running upper beam. Its thickness can be reduced by means of a transverse stiffeners under the profile.

**[0008]** The bleachers are dimensioned according to controlled deflection, when the maximum loading does not also exceed the yield or breaking limit of the metal, such as aluminium, or the structure's permitted torsions and deflections, which are the critical variables when selecting structural components. By using rack elements according to the invention a sufficiently rigid structure is obtained, the deflections and torsions of which remain very small. The stress values appearing in the structure remain far from the yield and breaking limits.

**[0009]** The mutually identical support structures, preferably lattice girder structures, are located at different balance points of the bleachers, in which the support structure comprises an obliquely downwards running upper beam, on which the rack element is supported and various pedestal structures at the different ends of the rack element.

**[0010]** The support structure comprises a first vertical beam, a lower beam running horizontally in the structure's lower part, and a support beam running obliquely above at an angle of about 30 degrees to the horizontal.

**[0011]** In the lattice girder structure, a diagonal support beam, which joins the upper support beam in its central area.

**[0012]** In the structure, the vertical beams join the base plates at their lower ends.

**[0013]** The rack elements form the structure's principal stiffening component and are preferably of aluminium. The seats are attached to them.

**[0014]** The rack element is a sheet-metal structure, the sheet thickness of which is in the range 2.5 - 6 mm and preferably 3 - 4.5 mm. The height of the rack element's vertical sheet is preferably 400 mm and its total depth is preferably 800 mm, of which the seat accounts for about half. At the lower and upper edges of the rack there are individual holes at regular intervals for attachment means such as bolts. From the sides of the rack elements protrude perforated angle supports acting as attachment parts, which also comprise perforation, by which they are attached to the rack elements, for example by bolts. The angle supports are welded to a pedestal structure, such as the oblique upper support beam of the lattice girder structure. Alternatively the rack elements are welded directly to the oblique beams and form bleacher blocks, which are then joined to each other.

**[0015]** There is a vertical sheet part in the rack element, to which a horizontal sheet part is attached at a 90-degree angle, on top of which the seat part is attached by screws. Behind the horizontal wall part's seat part and attached to which is a downwards running flanging, i.e. strip about 4-cm long, which ends at the foot strips of the foot space, which in turn ends at an upwardly flanged edge strip. Thus a sufficient foot space is formed in such a way that the toes of shoes do not strike the seat part. In other words, the rack element comprises a horizontal portion of the rack element, i.e. between the seat portion and the foot space there is an elongated flanging. Generally the height of this elongated strip 146 is 3 - 9 %, preferably 5 - 7 % of the length of the horizontal portion 145.

**[0016]** The rack element's upwardly flanged edge strip comes against the upwardly running vertical wall of the next rack element and it attached to it by bolts or other attachments, which are taken through the holes in the rack elements and the angle support.

**[0017]** The rack parts are attached to the angle supports acting as attachment parts of the pedestal structures, such as the lattice girder structures, by attachments such as bolts or screws.

**[0018]** The angle supports are formed of a first sheet part and a second sheet part at an angle of more than 90 degrees to it. The angle supports are preferably welded to the support structure's upper beam at a distance L2. L2 is preferably 30 cm. The rack elements are attached with bolts, screws, or other attachments to the said angle supports. Thanks to the angle supports, the rack elements are attached moment-rigidly to the pedestal structures, such as to the lattice girder structure at its upper beam.

**[0019]** The bleachers according to the invention thus comprise the pedestal structure, preferably the lattice girder structures, in a first vertical plane T1, a second vertical plane T2, a third vertical plane T3..., and an n<sup>th</sup> vertical plane Tn. The support structures, i.e. the pedestal structures are located at the ends of each rack element. The rack element's length is about 3000 mm.

**[0020]** The pedestal structures, such as lattice girder structures, are mutually identical. They are preferably welded metal structures and most preferably aluminium structures. According to the invention, the lattice structures are joined by the rack elements, to which the seats are attached detachably by screws.

**[0021]** The rack elements are flanged sheet-metal structures. Thanks to the flanging, a stiffener structure is formed and, for example, a foot-space structure is implemented. The flanging thus has several functions. By the edge flanging of the rack element's front edge and rear edge, attachment strips are formed, from which the element is attached detachably to the rack elements above and below it.

**[0022]** The under-surface of the rack elements' horizontal sheet part comprises preferably stiffeners, preferably stiffening parts, which are point-welded to the rack element. Preferably a 3000-mm long rack element comprises four L-profile stiffeners of metal on its under-surface. The distance of the stiffeners from each other is roughly the length of the profile's horizontal part, but distributed evenly over the length of the whole rack element.

**[0023]** The bleachers according to the invention are easy to erect and dismantle again. The structure is also cheap.

**[0024]** The bleachers according to the invention are characterized by what is stated in the Claims.

**[0025]** In the following, the invention is described with reference to some preferred embodiments in the accompanying figures, to which the invention is not, however, intended to be solely restricted.

#### List of figures

#### **[0026]**

Figure 1 shows the bleachers axonometrically from one end.

Figure 2a shows the bleachers from the direction of arrow k1 of Figure 1.

Figure 2b shows the bleachers in a partial axono-

metric view of only two rack elements with one seating row attached.

Figure 3 illustrates a rack element in an axonometrical view.

Figure 4 shows a rack element from the direction of arrow k2w of Figure 3.

Figure 5a shows a top view of a rack element.

Figure 5b shows a cross-section A-A of Figure 5a.

Figure 6a shows a stiffener part axonometrically. In Figure 6b the stiffener part is seen from the direction of arrow k3 of Figure 6a and in Figure 6c the stiffener part is seen from the direction of arrow k4 of Figure 6b.

Figure 7a shows axonometrically the detachable attachment of the rack element to the upper beam of the pedestal structure.

Figure 7b shows an angle support axonometrically and in Figure 7c the angle support is seen from the direction of arrow k5 of Figure 7b. In Figure 7d the angle support is seen from the direction of arrow k6 of Figure 7b.

Figure 8a shows an alternative rack element.

Figure 8b shows an end view of the rack element of Figure 8a.

Figure 9 shows an oblique beam that is more preferred than a previous one.

Figure 10 shows a variation of the rack element, arranged particularly for long spans.

**[0027]** Figure 1 shows the bleachers 10 axonometrically. In Figure 2a shows the bleachers' pedestal structure 40 from the direction of arrow k1 of Figure 1. Figure 2b shows the bleachers 10 in an axonometric partial view.

**[0028]** The bleachers according to the invention comprises lattice girder structures as the pedestal structures 40, which join the rack elements 14 i.e. racks, to which the seats 12 are detachably attached. The structure is metal and most preferably aluminium.

**[0029]** The triangular lattice girder structure 40 comprises a first vertical beam 401 and a second vertical beam 403. Between the said vertical beams above is a support beam 16 running obliquely downwards. Below the vertical beams are joined by a lower beam 404. The aforesaid beams delimit a triangular area, across which a support beam 402 runs diagonally. At its lower end it joins the junction of the first vertical beam 401 and the lower beam 404. At its upper end it joins the centre area E of the upper support beam 16. The diagonal support beam 402 is in its longitudinal axis at an oblique angle relative to the horizontal plane.

**[0030]** Support plates 404 and 405, which lie against the ground or floor, are placed at the lower ends of the vertical beams 401 and 403.

**[0031]** The uppermost rack elements 14' shown in the figures do not require a strip for the foot space in connection with the vertical edge 146, instead in the rearmost of the relevant rack elements 14' there is only the long downwardly extending vertical edge 146.

**[0032]** Correspondingly, in the bleachers 10 the lowest rack element 14" is only a foot strip 146b comprising an edge 149, to which one first rises when coming to the first row of seats.

**[0033]** It is obvious that the bleachers 10 comprise steps rising at a suitable point in the length of the bleachers. They are not separately presented in the application.

**[0034]** Figure 3 shows a rack element 14 axonometrically. It comprises an edge strip 148 at its front side and attachment holes D3 in it, as well as holes D3 in the lower part of the vertical wall 144.

**[0035]** The edge strip 148 connects at an oblique angle to the vertical wall 144, which, when the rack element is installed in place, runs vertically upwards and connects to the horizontal wall 145, which is horizontal.

**[0036]** In the horizontal wall 145 there is a seat portion 146a and a foot-space portion; behind the strip 146 running down from the foot strip 146b. Seats 12 with backs are detachably attached on top of the seat portion 146a. The wall portion 146a of the horizontal wall ends in a short downward flanging, i.e. the strip 146, which connects to the horizontal foot strip 146b, which further comprises at its end an upwardly running edge strip 149, with perforations D5.

**[0037]** Figure 4 shows the rack element 14 seen from the direction of the arrow k2 of Figure 3.

**[0038]** Figure 4 shows a rack element 14 with at its front edge an edge strip 148, which connects to the vertical wall 144 at an oblique angle. The horizontal sheet part 145 is at an angle of about 90 degrees to the vertical sheet part 144 and runs horizontally when the rack 14 and bleachers 10 are installed in place.

**[0039]** Seats 12 are placed on top of the seat portion 146a of the horizontal wall 146. After the seat portion 146a is a downwards running strip 146, which ends in the horizontal foot strip 146b, at the rear edge of which is an upwardly running edge strip 149, which comprise perforations D5 at both ends.

**[0040]** The strip comes against the vertical sheet part 144 of the upper/lower vertical sheet part 144 and it is attached to it by attachments, such as bolts carried through the perforations.

**[0041]** Under the rack element's 14 horizontal sheet part 145 are stiffeners 142 such as metal L-profiles. They are stiffener parts of metal such as aluminium and are point welded to the horizontal sheet's 145 under-surface. They are preferably four, i.e. at about 740-mm intervals (700 - 780 mm over a sheet length of about 3 m). The stiffener part, i.e. the stiffener fin 142 is preferably 2-5-mm thick.

**[0042]** Figure 5a shows a top view of a rack element 14 and Figure 5b shows a cross-section A-A of the finned stiffener part 142 of Figure 5a.

**[0043]** Figure 6a shows the stiffener part 142 axonometrically. In Figure 6b the stiffener part, i.e. finned part 142 is seen from the direction of arrow k3 of Figure 6a and in Figure 6c the finned part 142 is seen from the direction of arrow k4 of Figure 6a.

**[0044]** The stiffener part 142 is preferably an L-profile, which comprises a sheet part 1424 with a second sheet part 1422 at a 90-degree angle to it. The upper edge 1426 of the relevant sheet part 1422 is shaped to correspond to the shape of the rack's 14 under-surface.

**[0045]** Figure 7a shows the rack element's angle support 18 and pedestal structure 40, such as a lattice girder structure joined together by a screw or bolt joint. Figure 7b shows axonometrically the angle support 18 used in the joint. Figure 7c shows the angle support 18 of Figure 7b from the direction of arrow k5 of Figure 7b. Figure 7d shows the angle support 18 from the direction of arrow k6 of Figure 7b. The joining of the pedestal structure 40 such as a lattice girder structure and the rack element 40 to each other detachably uses an angle support 18, which comprises two sheet parts 182 and 183 at an angle of over 90 degrees to each other. Between the sheet parts 182 and 183 is a bend 184. At the ends of both sheet parts 182 and 183 is perforation C3, C4 for attachment means such as bolts.

**[0046]** Figures 8a and 8b shows a slightly altered rack element. The rack element's structure is otherwise identical, but in it vertical stiffeners 141 are used in the vertical wall.

**[0047]** One of the angle support's 18 sheet parts 182 comes against the rear surface of the rack's 14 vertical wall 144 and the other sheet part 183 comes against the rack element's 14 front edge's 148 under-surface in such a way that relevant parts' perforations D3, D4; C3, C4 are aligned. The attachments such as bolts are fed through the perforations. The angle support 18 is welded onto the pedestal structure's 40 slanting downwards upper beam 16.

**[0048]** The second adjacent rack element 14 is detachably joined in the same way to the angle support's 18 second end.

**[0049]** In economy calculations it is been surprisingly shown that the generally available aluminium sheet 1.5 m x 3 m forms the clearly most cost-effective structural solution, of which the 3-m dimension determines the rack element's width. The other dimension 1.5 m is used nearly entirely, if it is flanged four times to create the desired stiffened shape. Flanging achieves both a stiffener function and also other functional effects, for example, relating to attachments.

**[0050]** The slanting beam's 16' profile according to Figure 9 has proven to be the most preferred. An upper flange is added to a U profile open at the sides. The sheet thickness of the aluminium profile is 3 - 7 mm, preferably 4 - 5 mm. When the webs of two adjacent bleacher/step element's oblique beams 16' are bolted together, a structure with substantial rigidity and load-bearing is obtained.

**[0051]** According to the latest development, the angle supports of Figures 7a- 7d are no longer used, instead the aluminium rack elements 14 are welded to each other and to the slanting beams (16 or 16'). Assembling an entire aluminium bleacher structure by welding has proven economical. The bleachers are formed of modules

dimensioned for transportation, the support structure of which is entirely welded together.

**[0052]** The rack element according to Figure 10 contains a variation, in which the horizontal portion's 145 longitudinal flanging 146 is in a different direction to previous embodiments. The foot-space portion 146b is higher than the seat portion. The seat portion thus preferably includes a riser (not shown), by which the seat's bottom is set higher than the foot-space portion.

**[0053]** In addition, according to the latest embodiment the rack elements are made from reeled sheet, when, for example, a 6600-mm long rack element, which is supported at its ends on slanting support, can be made from profile according to Figure 10. Stiffener flanges are at both edges. The foot-space (146b) portion is 603 mm and the seat portion (146a) 331 mm, and between them is a 55-mm vertical portion (strip 146) with two flangings. Over long spans turning the vertical portion (strip 146) downwards reduces considerably the vertical sheet part's 144 height, which balances the tension distribution of the loaded rack element. Thus a thickness of only 4 mm is enough with corresponding transverse stiffeners (Figure 8b stiffeners 141 and 142), e.g. in that 6600-mm span. Generally the rack element's long span is then 4 - 8 m, preferably 6-7 m.

## Claims

### 1. Lightweight bleachers (10), in which

- the bleachers (10) comprise rack elements (14) bound to each other front and back, each of which comprises,
- a sheet-metal structure, in the profile of which is at least a vertical wall (144) as a flanged structure (144) and a horizontal portion (145) relative to it, and in it a seat portion (146a), to which the seats (12) are attached, and the foot space (146b) of the next higher row of seats,
- the rack elements (14) are attached to pedestal structures (40) at both ends of the rack element (14) and that
- the attachment takes place to an obliquely downwards running support beam (16) of the pedestal structure (40),
- the upper and/or lower edge of the rack element (14) includes a flanged edge strip (148, 149) in order to stiffen the structure,

**characterized in that** the rack element (14) comprises a longitudinal flanged strip (146) between the seat portion (146a) and foot space (146b) in the horizontal portion (145) of the rack element's profile.

### 2. Bleachers (10) according to Claim 1, **characterized in that** at least the rack element (14) is of aluminium and that the rack element's (14) sheet thickness 2.5

- 6 mm and preferably 3 - 4.5 mm.

### 3. Bleachers (10) according to Claim 1 or 2, **characterized in that** the pedestal structure (40) is a lattice girder structure, which comprises a first vertical beam ((401) and a second shorter vertical beam (403) and underneath a lower beam (404) between them, an obliquely downwards running support beam (16), and a support beam (402) that runs from the first vertical beam's (401) lower part to the support beam's (16) centre area (E), and that the vertical beams (401, 402) comprise support plates (404, 405) at their lower ends coming against the ground or floor.

### 4. Bleachers (10) according to any of the above Claims 1-3, **characterized in that** behind the rack element's (14) horizontal seat portion (146a) is a downwardly oriented flanged strip (146), which permits a spacious foot space to be formed, in such a way that a shoe's toe will not strike the seat.

### 5. Bleachers (10) according to the above Claim 4, **characterized in that** the edge strip (146) joins the foot-space strip (146b), which joins the upwardly running edge strip (149) and that in the rack element's (14) front part is an edge strip (148), running obliquely to the vertical, and joining the vertical wall (144).

### 6. Bleachers (10) according to any of the above Claims 1-5, **characterized in that** in them is an angle support (18), which is attached to the bleachers' (10) pedestal's (40) downwards obliquely running support beam (16) and which angle support (18) is joined to the end of the rack element (14) by attachment means, such as bolts or similar.

### 7. Bleachers (10) according to the above Claim 6, **characterized in that** that angle supports (18) are attached by welding at a distance from each other to the support beam (16) and that the angle support (18) comprises a fold (184) and sheet parts (182, 183), which comprise perforations (C3, C4), which are aligned with the rack element's (14) perforations (D4, D5) to feed the attachment means through the perforations when assembling the bleachers (10).

### 8. Bleachers (10) according to any of the above Claims 1 - 5, **characterized in that** at least one rack element (14) is attached by a welded joint to the obliquely downwards running support beam (16).

### 9. Bleachers (10) according to any of the above Claims 1 - 8, **characterized in that** there are stiffener parts (142) welded to the under-surface of the rack element (14).

10. Bleachers (10) according to the above Claim 9, **characterized in that** on the inside of the rack element's (14) front part are vertical stiffener parts (141) welded to it and joined to the horizontal stiffener parts (142). 5
11. Bleachers (10) according to Claim 9 or 10, **characterized in that** the thickness of the stiffener parts' (141, 142) sheet is in the range 2 - 5 mm.
12. Bleachers (10) according to any of the above Claims 1 - 11, **characterized in that** the said longitudinal strip (146) in the form of two flangings in the rack element's horizontal portion (145) raises the foot-space portion (146b) in the rack element's (14) profile higher than the seat portion (146a). 10  
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13. Bleachers (10) according to any of the above Claims 1 - 12, **characterized in that** the height of the said longitudinal strip (146), formed of two flangings in the rack element's horizontal portion (145), is 3 - 9 20  
%, most preferably 5 - 7 % of the length of the horizontal portion (145).
14. Bleachers (10) according to the above Claims 10, 12, and 13, **characterized in that** the rack element's span is 4 - 8 m, most preferably 6 - 7 m. 25

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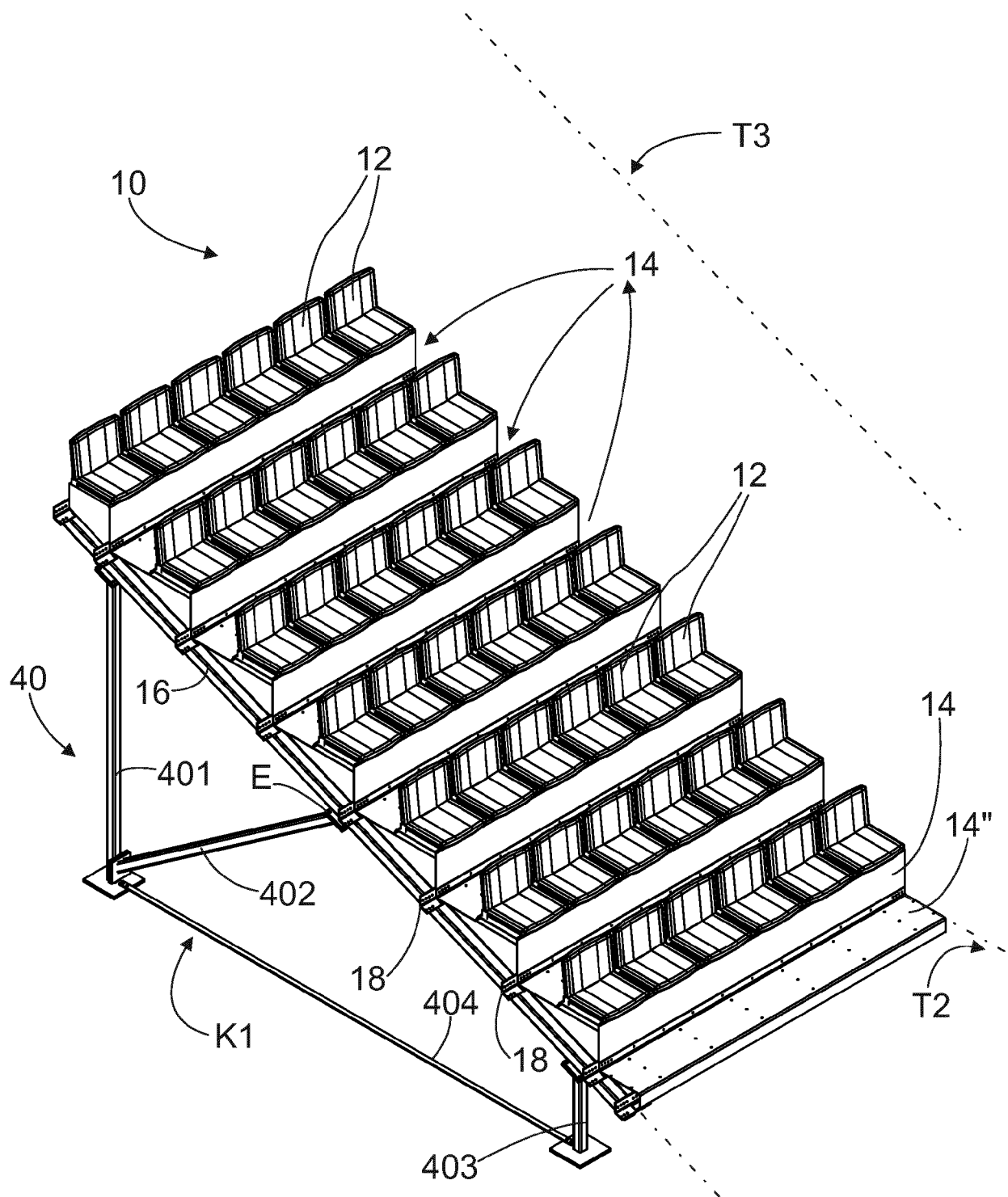


Fig. 1

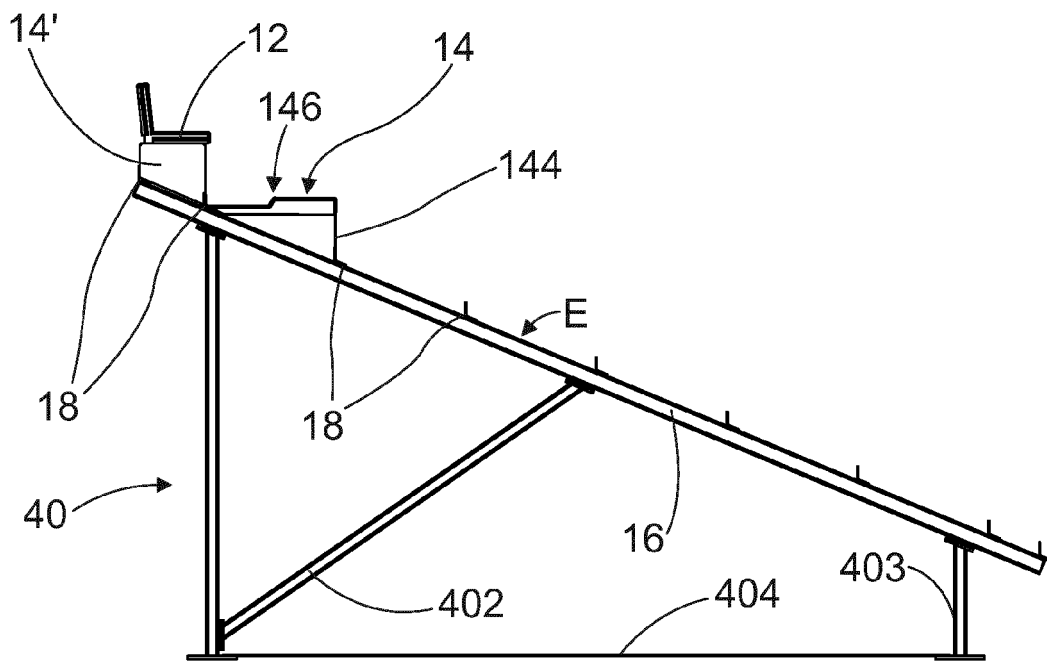
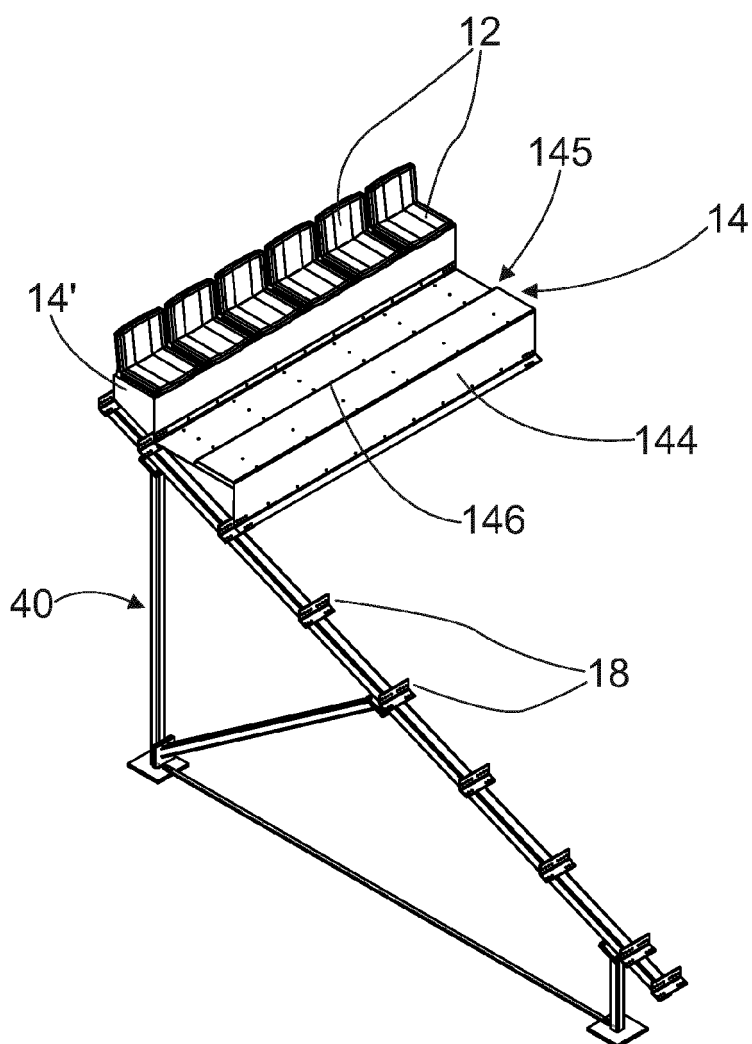
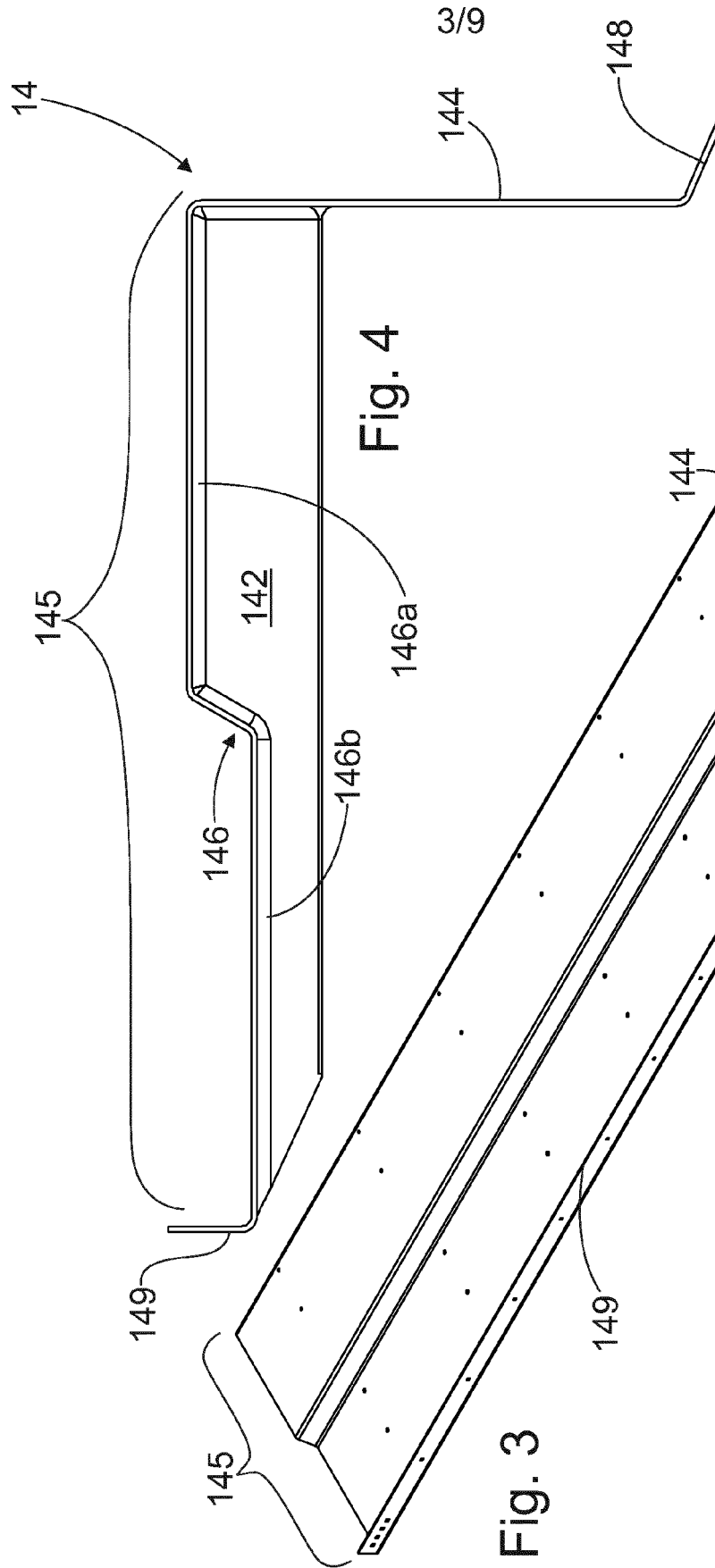


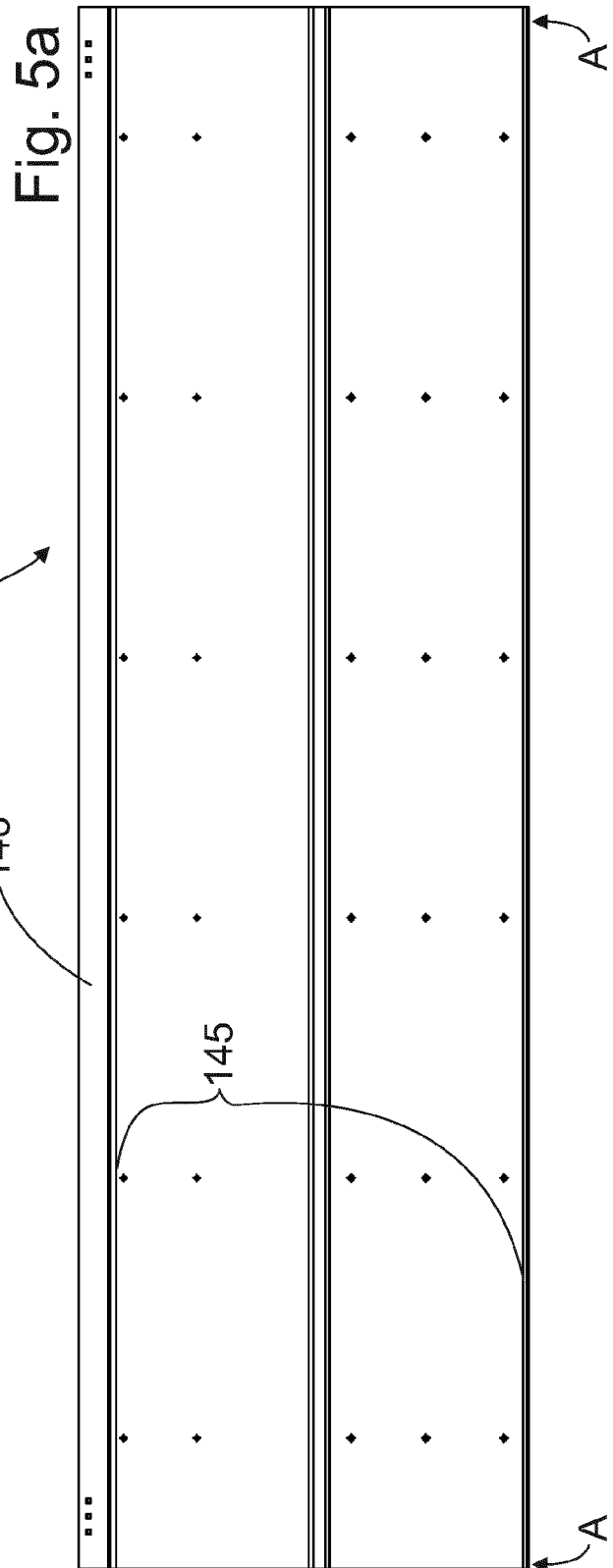
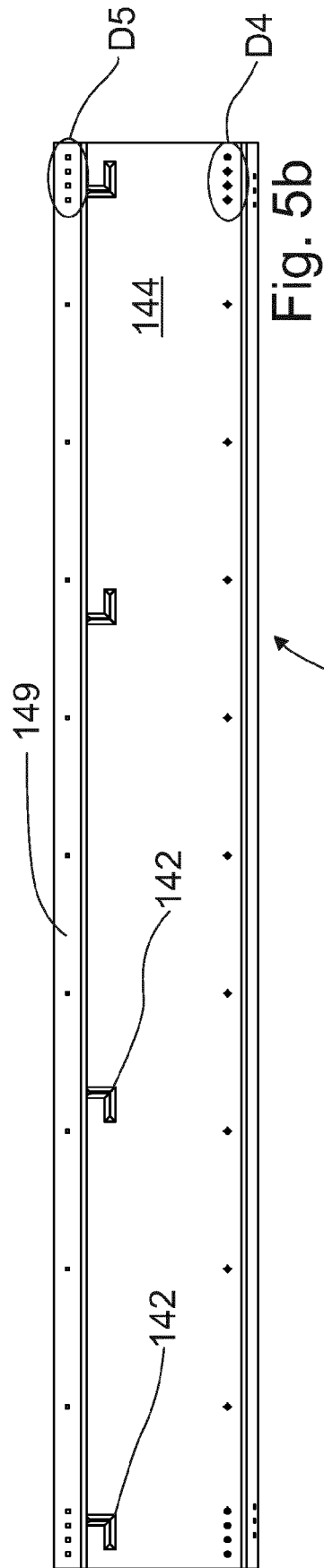
Fig. 2a

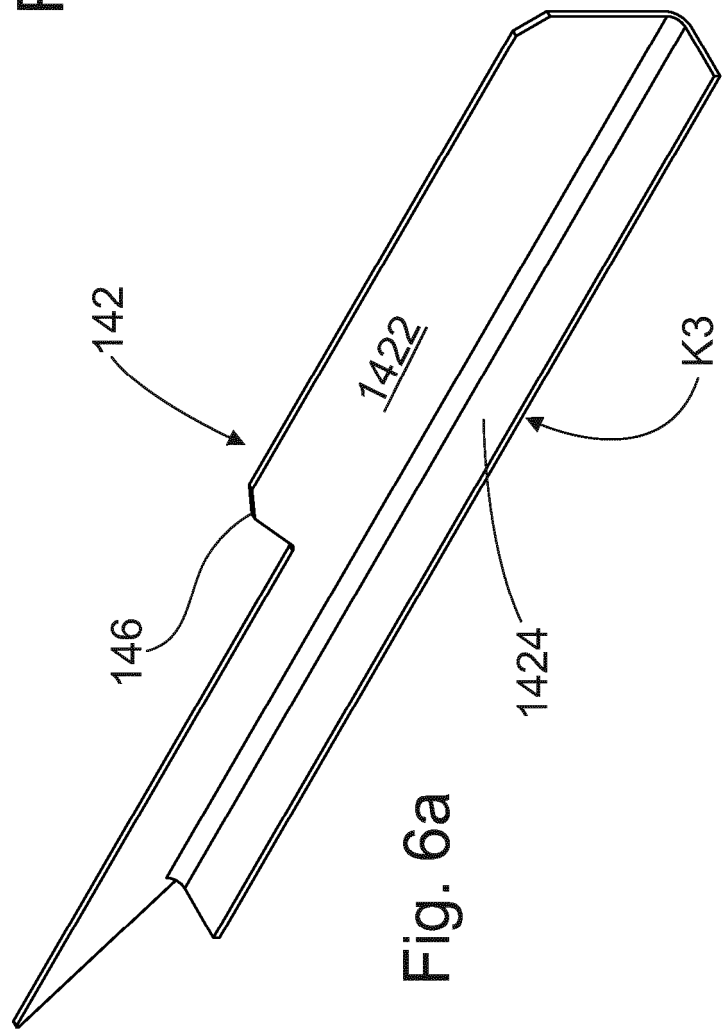
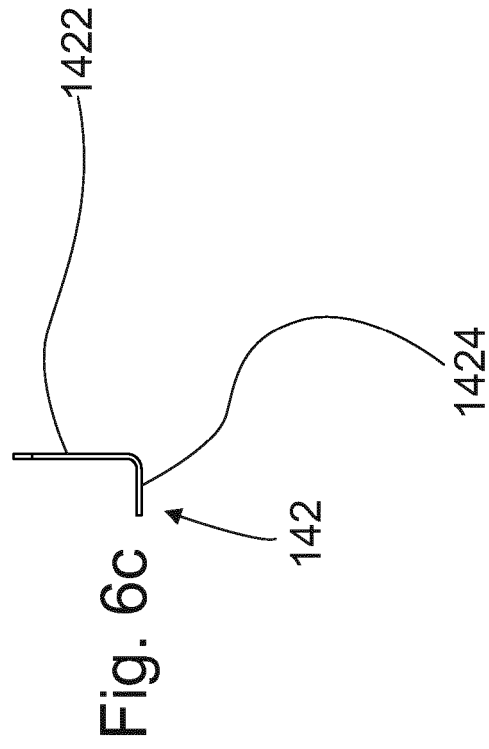
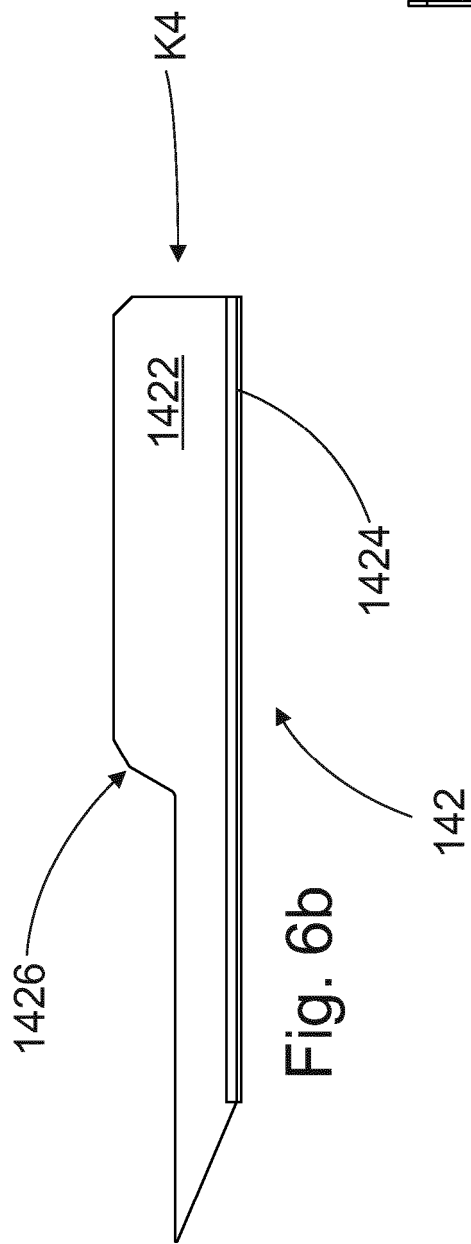


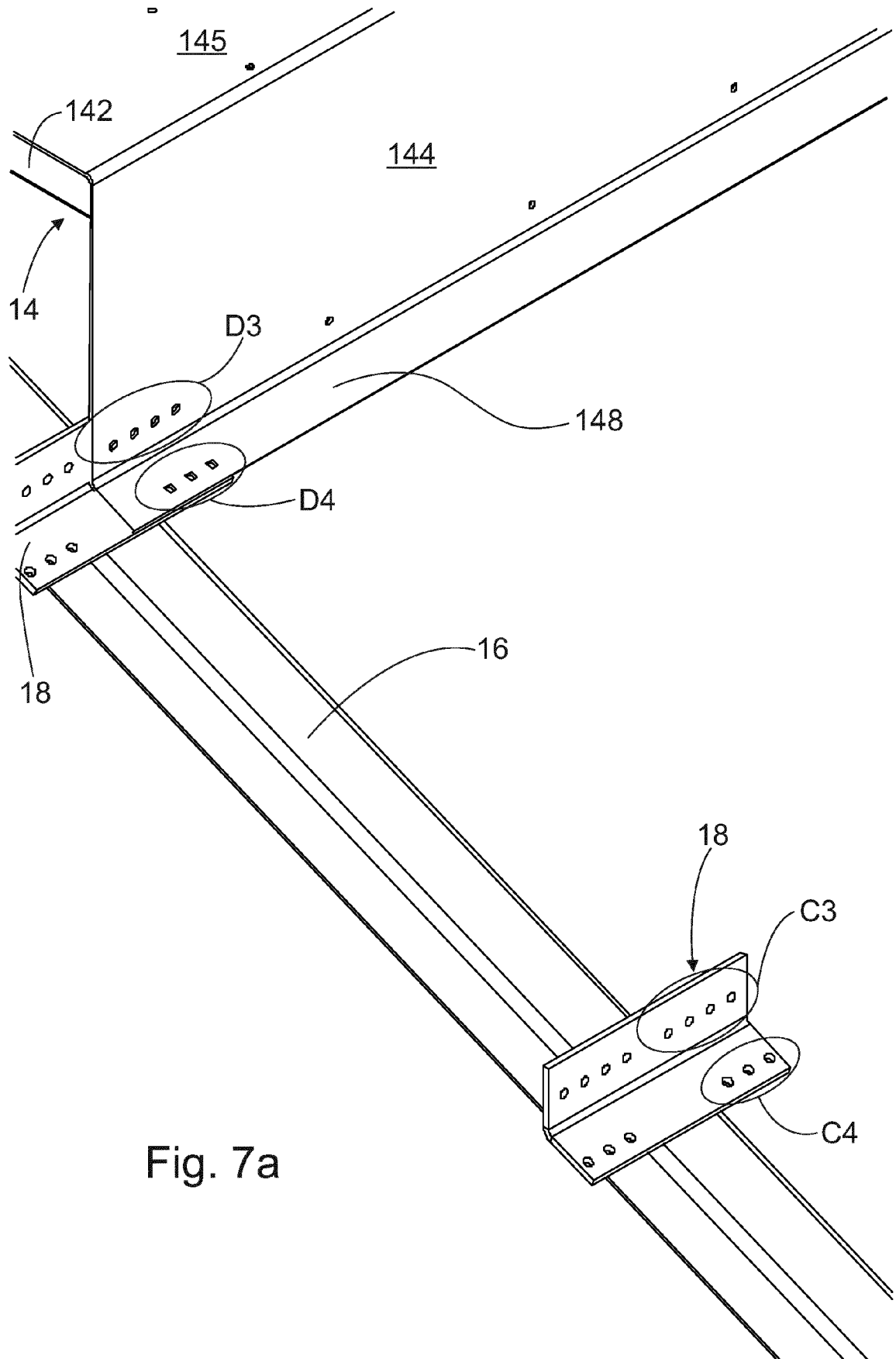
**Fig. 2b**

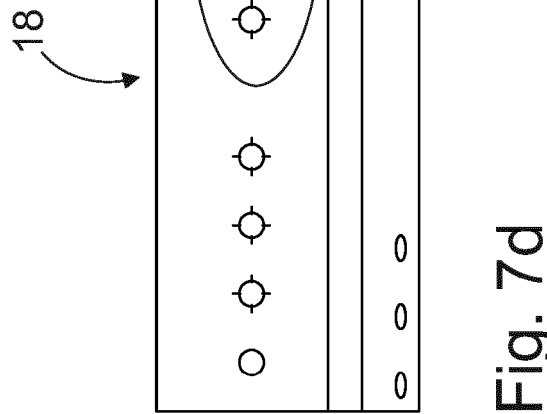
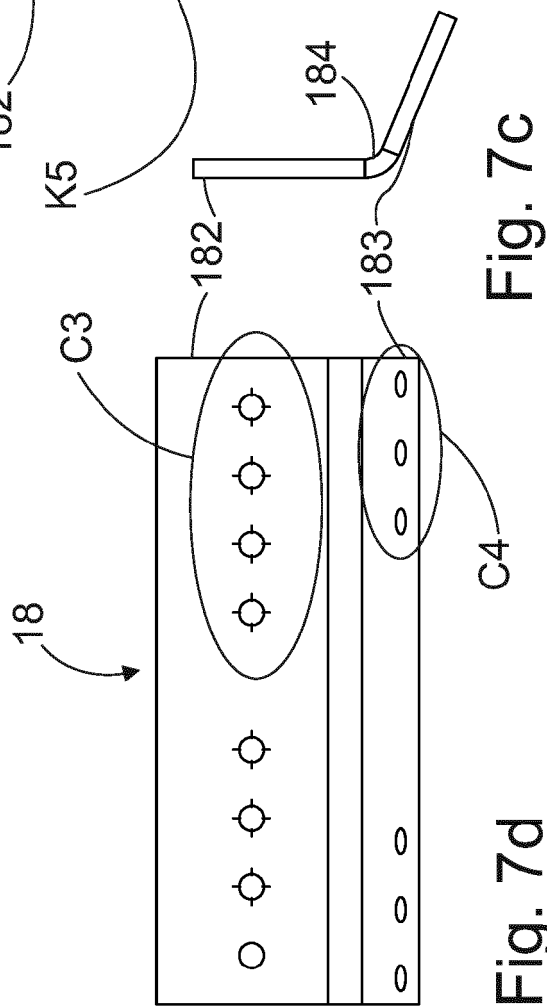
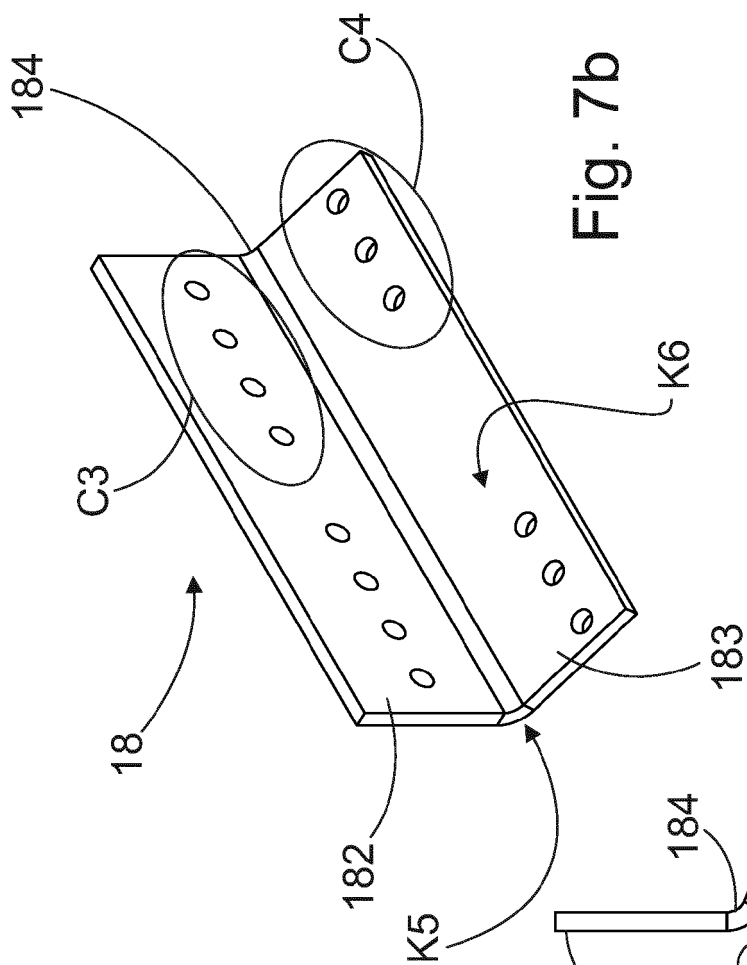












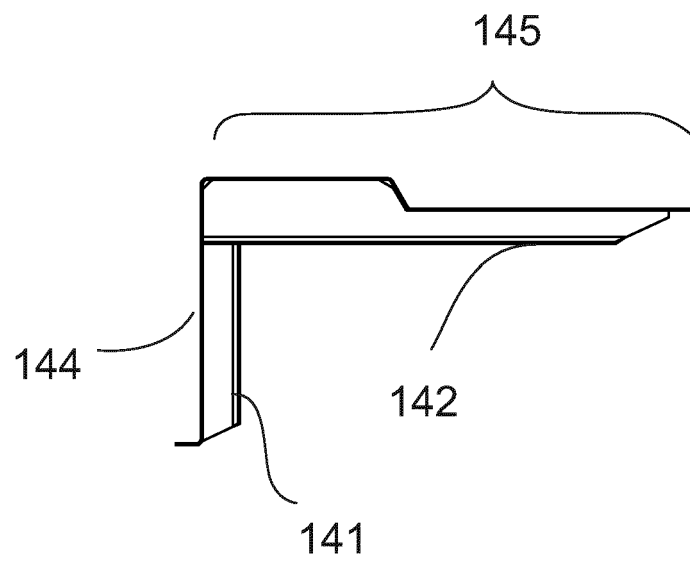
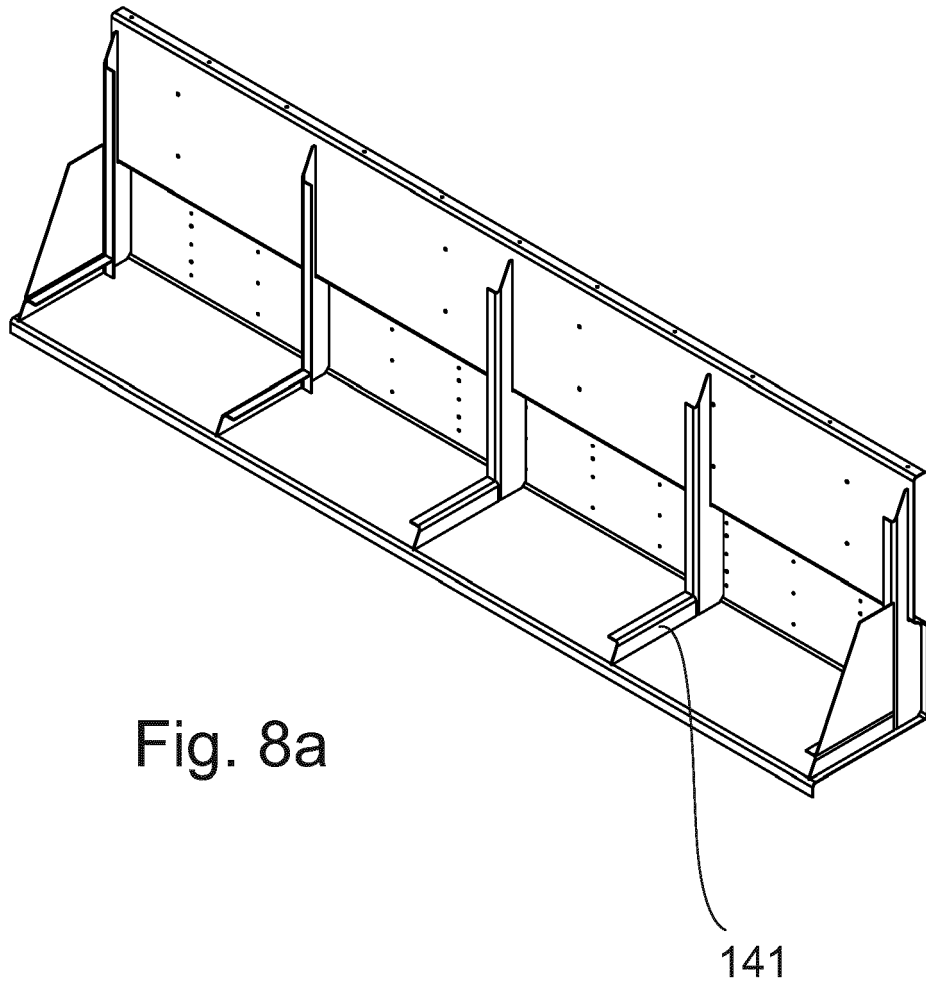


Fig. 8b

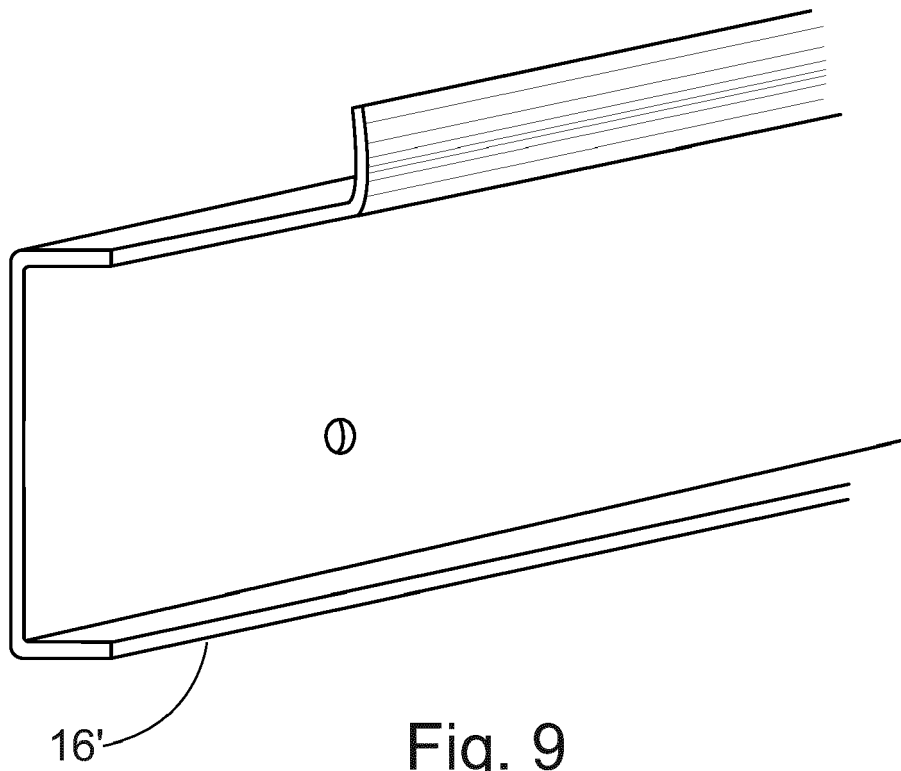


Fig. 9

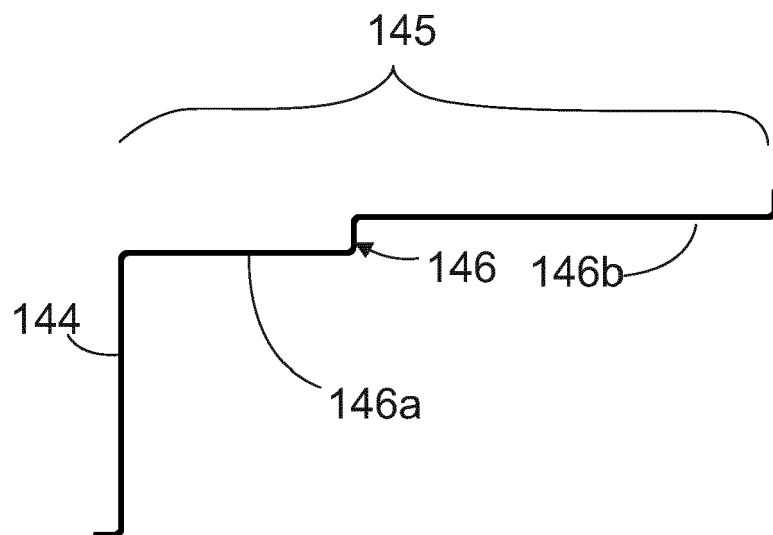


Fig. 10



## EUROPEAN SEARCH REPORT

Application Number  
EP 20 15 8748

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| DOCUMENTS CONSIDERED TO BE RELEVANT                                              |                                                                                                        |                                                                         |                                         |
|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|-----------------------------------------|
| Category                                                                         | Citation of document with indication, where appropriate, of relevant passages                          | Relevant to claim                                                       | CLASSIFICATION OF THE APPLICATION (IPC) |
| X                                                                                | US 5 159 788 A (MERRICK BRUCE C [US])<br>3 November 1992 (1992-11-03)                                  | 1,3,4,<br>12-14                                                         | INV.<br>E04H3/12                        |
| Y                                                                                | * column 3, line 53 - column 6, line 6;                                                                | 2,6,8-11                                                                |                                         |
| A                                                                                | figures 1-12 *                                                                                         | 5,7                                                                     |                                         |
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