(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 464 802 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
24.01.2018 Bulletin 2018/04

(21) Application number: **10752098.3**

(22) Date of filing: **10.08.2010**

(51) Int Cl.:
E04G 7/10 *(2006.01)* ***E04G 21/32*** *(2006.01)*
E04G 5/14 *(2006.01)*

(86) International application number:
PCT/GB2010/001509

(87) International publication number:
WO 2011/018615 (17.02.2011 Gazette 2011/07)

(54) **EDGE PROTECTION SYSTEM**

KANTENSCHUTZSYSTEM

SYSTÈME DE PROTECTION DE BORD

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR

(30) Priority: **10.08.2009 GB 0913927**
10.08.2009 GB 0913926

(43) Date of publication of application:
20.06.2012 Bulletin 2012/25

(60) Divisional application:
16197556.0 / 3 159 461

(73) Proprietor: **Combisafe International Aktiebolag**
831 34 Östersund (SE)

(72) Inventor: **GOLAUB, Roger**
Northamptonshire NN5 4EH (GB)

(74) Representative: **Houghton, Mark Phillip et al**
Patent Outsourcing Limited
1 King Street
Bakewell, Derbyshire DE45 1DZ (GB)

(56) References cited:
EP-A2- 1 878 850
DE-B- 1 212 707
JP-A- 2003 105 966
US-A- 3 521 332
US-A1- 2003 178 253
US-A1- 2006 054 393
US-A1- 2008 128 205
US-A1- 2009 159 865
US-B1- 6 220 577

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 2 464 802 B1

Description

Field of the Invention

[0001] This invention relates to an edge protection system for use as a temporary guard rail for a scaffolding system and to an adjustment device for use in such an edge protection system.

Background to the Invention

[0002] Known scaffolding systems are generally of two kinds; those comprising customised proprietary components and those comprising a selection of standard tubes and fittings. The first kind typically requires skilled construction and has parts configured to clip together in a specific arrangement, which brings attendant design constraints. In addition, the first kind is usually so customised to suit a particular application that it is not suitable for re-use and is generally scrapped once the project is complete. The second kind is generally considered more versatile but is labour intensive as it requires parts to be clamped or welded together. Also, at the end of the use of a particular construction the welded parts are generally severed by hot works and this can be dangerous as well as time-consuming.

[0003] Scaffolding systems are typically used alongside buildings or other structures either in the construction or maintenance of such structures. A scaffolding system will comprise vertical members (also known as standards) to which are connected two sets of horizontal bars: ledger bars extending in use alongside the structure being built or maintained and transom bars extending towards, typically transverse to, the structure. The scaffold construction erected from the scaffolding system will also normally comprise diagonal brace bars to provide rigidity to the scaffold construction.

[0004] On each working platform level within a scaffold construction a temporary barrier (often referred to as an edge protection system) needs to be fixed to prevent workers from falling from the scaffold construction while working on the adjacent structure. This barrier typically comprises a steel mesh panel attached to upright posts. However, during both the construction of a scaffolding structure and the installation of a barrier, there is an increased risk of a worker falling from the structure.

[0005] Even if a post and mesh panel modular system can be installed safely, the resulting barrier restricts access to the building structure beyond the mesh; such access is often required for tasks such as casting concrete slabs and installing cladding or glazing panels. As a result, individual mesh panels are often removed to provide the required access and this leads to an increased risk of a worker falling from the scaffolding structure. In order to reduce this risk workers are often secured to the scaffolding by a lanyard to an anchor point on one side of the section from which the barrier has been removed. However, this can impede the ability of the worker to perform the task efficiently. In the case of casting concrete slabs the barrier is typically set at a minimum height to allow some degree of access and then adjusted to a new height once the slab is cast. However, this is not ideal as the barrier is not set at the required height relative to the structure throughout the process.

[0006] In addition, the area in which that worker is performing the task will need to be zoned off to prevent others from entering the area from which the barrier has been removed. This will also prevent access to other areas of the scaffold construction beyond that section where the barrier has been removed, thereby reducing the speed at which completion of the building structure can be effected. The document EP 1878850 A2 discloses all the features of the preamble of claim 1. It is therefore an aim of the present invention to provide an improved edge protection system and an adjustment device therefor.

Summary of the Invention

[0007] According to a first aspect of the present invention there is provided an edge protection system for a base according to claim 1. Thus, the present invention enables the attachment of a barrier to a base before the base is raised into position. Accordingly, the risk associated with working at height without a barrier (during either the erection of a scaffolding construction or the installation of a barrier) is eliminated. Furthermore, only a few individual components are required to be assembled when erecting the edge protection system and consequently construction of the edge protection system is quick, straightforward and requires minimal skill. In addition, disassembly of the edge protection system is also relatively quick and easy to perform since the barrier is releasably attached to the base. Thus, the danger associated with using hot works to remove the barrier is also eliminated. Moreover, embodiments of the invention do not require any tools to install or remove the barrier from the fixing means - manual manipulation being all that is required. A further advantage of the present invention is that the individual components may be re-used immediately, without requiring any maintenance or repair. Furthermore, aspects of the present invention provide for a sustainable system, the components of which can be reused in a variety of ways to suit a number of different applications.

[0008] A beam, a slab, a panel or any pre-manufactured floor element may constitute the base. The beam may be made from steel and the slab may be made from concrete.

[0009] The step of providing a fixing means on a base may comprise securing a fixing means to a base or providing a fixing means that is integral with a base.

[0010] The fixing means may be releasably secured to the base. Alternatively, the fixing means may be welded to the base.

[0011] The fixing means may comprise a socket or a plug configured for engagement with a part of the barrier

that constitutes a complementary plug or socket.

[0012] In the case where the fixing means is integral with the base, the fixing means may be constituted by a recess in the base, which forms a socket for receiving a part of the barrier that forms a complementary plug.

[0013] In any of the above cases, the socket may be in the form of a cylindrical tube and the plug may be in the form of a cylindrical rod.

[0014] An intermediate element may be provided between the fixing means and barrier to aid the engagement therebetween. The intermediate element may be constituted by a sleeve and may be formed from a plastics material.

[0015] The barrier may comprise at least one opening configured to allow access therethrough, the at least one opening being configured to enable a worker to work beyond the barrier whilst the barrier remains in place. It will be understood that such a structure may allow a large concrete slab to be cast without the need to adjust the edge protection system. In addition, tasks such as cladding and glazing can be performed without compromising safety. The barrier may be provided in any convenient size (for example, in 1m or 2m widths, having a height of between 1m and 1.5m). The barrier comprises at least two horizontally spaced apart uprights with an upper and a lower horizontal element spanning therebetween. The lower horizontal element is preferably spaced from the base. At least one intermediate horizontal element may be provided between the upper and lower horizontal elements. The uprights may be of substantially similar height and a lower end of each upright may constitute a plug or socket for engagement in a complementary socket or plug of two respective fixing means.

[0016] In the edge protection system, at least one additional barrier and respective fixing means are provided. Coupling means are provided to couple the barriers together. The coupling means may be releasable and may comprise a clamp, clip, clasp or strap. The coupling means may be configured for a snap-fit engagement with an adjacent barrier. Furthermore, the coupling means may be spring-loaded and may be configured such that in its rest position it can grip an adjacent barrier and in its tensioned position it can be released from said barrier. The coupling means may be provided on one end of a barrier for coupling to the closest end of an adjacent barrier so that the barriers are coupled end to end.

[0017] The at least one additional barrier may comprise at least two horizontally spaced apart uprights with an upper and a lower horizontal element spanning therebetween. The lower horizontal element is preferably spaced from the base. At least one intermediate horizontal element may be provided between the upper and lower horizontal elements. A lower end of at least one of the uprights may extend lower than the lower horizontal element and may constitute a plug or socket for engagement in a complementary socket or plug of the fixing means. At least one of the other uprights may extend no lower than the lower horizontal element. The coupling means may be provided on the at least one of said other uprights.

[0018] A coupler is provided to allow an additional barrier to be coupled to an adjacent barrier with a degree of overlap therebetween; the coupler being attachable to the barrier at any point along the length of the barrier and wherein the coupler is configured to secure the at least one additional barrier to said barrier. Accordingly, the coupler allows for an edge protection system of any size (greater than the size of one barrier) to be constructed and therefore allows for any length of base to be protected.

[0019] The coupler comprises a post having a first series of coupling means configured for attaching the post to the barrier. A second series of coupling means configured for attaching the additional barrier to the post are provided on the additional barrier. The post may be configured for attachment between at least two of the upper, lower or intermediate horizontal elements of a barrier. The coupling means of the additional barrier constitute the second series of coupling means for attaching the additional barrier to the post, as opposed to the closest end of an adjacent barrier.

[0020] In a second embodiment, not falling under the scope of the present invention the barrier comprises at least one upright coupled to a laterally extending body, the at least one upright being laterally moveable along the length of the body. The lower end of the at least one upright may constitute a plug or socket for engagement in a complementary socket or plug of the fixing means. A locking means may be provided to fix the position of the at least one upright with respect to the body.

[0021] Two horizontally spaced apart uprights may be provided, each being laterally moveable along the length of the body. The body may comprise an upper and a lower horizontal element. An intermediate horizontal element may be provided therebetween. A vertical support post may be provided between the upper and lower horizontal elements to provide a more rigid structure and to minimise the deflection of the upper and lower horizontal elements.

[0022] In either of the above embodiments, the barriers may be of any shape or size (for example, planar or curved, rectangular or square). Thus, an edge protection system can be constructed to suit any shape of scaffolding or building structure.

[0023] In addition, the barriers may further comprise attachment means for attaching a mesh panel. In this embodiment the mesh panel can provide increased containment but can be selectively removed to provide local (but safe) access through a barrier.

[0024] The attachment means may be constituted by at least one carabiner. The attachment means may be pivotally mounted on the barrier.

[0025] A supplementary mesh panel may be provided for extending the height of said mesh panel so as to provide even greater containment when required. The supplementary mesh panel may include an anti-roll device to prevent the supplementary mesh panel from rotating

about a horizontal axis when in use.

[0026] According to a third aspect not forming part of the present invention, there is provided a guard rail comprising a barrier, at least one additional barrier and a coupler; the coupler being attachable to the barrier at any point along the length of the barrier and wherein the coupler is configured to secure the at least one additional barrier to said barrier.

[0027] It will be understood that, in use, the coupler is attached to an intermediate point on the barrier, as required, and the additional barrier is then secured to the coupler so as to couple the barrier and the additional barrier together in an overlapping configuration. Thus, the third aspect of the present invention enables a guard rail of any size (greater than the size of one barrier) to be constructed.

[0028] The barrier, the at least one additional barrier and the coupler may comprise any of the features described above in relation to the edge protection system.

[0029] According to a fourth aspect also not forming part of the present invention there is provided a barrier comprising at least one upright coupled to a laterally extending body, the at least one upright being laterally moveable along the length of the body.

[0030] The barrier according to the fourth aspect of the invention may comprise any of the features described above in relation to the edge protection system and in particular, in relation to the barrier described in the second embodiment.

[0031] An advantage of such a barrier is that the position of the supporting upright can be varied to provide the desired body width at either side of the upright. This means that the barrier can be mounted with its upright close to another structure by simply moving the upright towards one end of the body. This is particularly useful when erecting a barrier to fill a gap of fixed length (e.g. along a beam) since the gap may not be filled by a whole number of barriers erected end to end. In such a case, one of the barriers (usually an end barrier) can be configured such that a part of the body of one barrier overlaps (i.e. lies adjacent to) a part of the body of another barrier and the degree of overlap can be selected by varying the position of the upright with respect to the body. Furthermore, the moveable nature of the upright can allow for better alignment with pre-fitted fixing means such as sockets welded to a base if said sockets are not positioned accurately (e.g. if they are not welded exactly 1m apart).

[0032] A further advantage of the barrier according to the fourth aspect of the invention is that only one type of barrier is required (regardless of the length of gap to protect) since the configuration of each can be independently adjusted as required, for example to provide the required degree of overlap. Also, as each barrier is of the same type they can be easily stacked and transported.

[0033] Thus, embodiments of the present invention comprise the use of a barrier comprising a framework of spaced vertical and horizontal members through which workers can safely reach beyond the barrier to the building structure. Where necessary, increased containment can be achieved by attaching a mesh panel to the barrier to block access there-through. In embodiments of the present invention such attachment can be achieved by having a series of carabiners rotatably mounted on the barrier and arranged such that they can grip onto a transverse member of a mesh panel to hold the panel adjacent the barrier.

[0034] In the case of casting concrete slabs, it is important that the edge protection system can be arranged to provide adequate protection both before and after the slab has been cast. Current ways to achieve this include using plastic tie wraps or another form of coupler to suspend the barrier at the desired height before and after the slab has been cast. However, traditional tie wraps and couplers are discrete items which are easily misplaced and may not be available when required. Furthermore they are awkward to use, especially when attempting to hold the barrier whilst fixing them in place. Moreover, additional tools are often required when employing such a coupler.

[0035] Although the use of a carabiner such as that described above, can address some of the difficulties, its fixed position with respect to the barrier limits its use in adjusting the height of the edge protection system. Also not forming part of the present invention is provided an adjustment device for an edge protection system.

[0036] According to a fifth aspect also not forming part of the present invention, there is provided an adjustment device for an edge protection system comprising a base unit with an attachment means for an edge protection element coupled thereto, the attachment means being movable along the base unit.

[0037] The attachment means may be configured for coupling a support means and a containment means together to form an edge protection system.

[0038] According to a sixth aspect also not forming part of the present invention, there is provided an edge protection system comprising a support means, a containment means and an adjustment device in accordance with the fifth aspect of the invention on one of the support means or the containment means.

[0039] According to a seventh aspect also not forming part of the present invention, there is provided a method of assembling an edge protection system comprising providing a support means, a containment means and an adjustment device in accordance with the fifth aspect of the invention on one of the support means or the containment means; placing the attachment means in a desired position with respect to the support means and/or containment means; and coupling the support means and containment means together via the attachment means.

[0040] Thus, the last three aspects described above enable the attachment of a containment means (e.g. mesh panel) to a support means (e.g. a post or frame barrier) in a number of different relative positions. Con-

sequently, it can be used to adjust the height of one component (e.g. the mesh panel) relative to the other (e.g. the barrier). Accordingly, the height of an edge protection system can be quickly and easily adjusted, say, to compensate for the height of a concrete slab once cast.

[0041] In addition, the fact that the attachment means is coupled to a base unit which can be permanently mounted on one of a support means or containment means results in the attachment means always being available for use and means that there is no need to fix the attachment means to both parts during use. This simplifies the task of coupling the support means and containment means together, which therefore reduces the time and effort spent on this task.

[0042] Moreover, embodiments of the invention do not require the use of tools to couple or decouple the components together - manual manipulation of the attachment means being all that is required.

[0043] The base unit may be configured for fixing to a support means or a containment means or it may form an integral part of a support means or a containment means. It will be understood that having an integral base unit helps to reduce the overall weight of the edge protection system and makes the system easier and cheaper to produce and assemble.

[0044] The support means may be constituted by a support post or barrier. The containment means may be constituted by a mesh panel.

[0045] The base unit may comprise marking to indicate where the attachment means should be positioned for a particular use. For example, when casting a slab of a particular height (e.g. 250mm) the base unit may indicate where to position the attachment means so that once a mesh panel is attached to the attachment means it is provided to the required height above the slab.

[0046] The attachment means may comprise a carabiner, a hook or a clasp. The attachment means may be rotatably or pivotally coupled to the base unit.

[0047] The base unit may be configured such that the attachment means is moveable in a substantially vertical and/or horizontal direction, when in use.

[0048] The base unit may include a slot along which the attachment means can slide. Both ends of the slot may be closed to retain the attachment means therein. In one embodiment, one end of the slot may be selectively opened to allow the attachment means to be removed and/or replaced.

[0049] A locking means may be provided to lock the attachment means in a desired position with respect to the base unit, when in use. The locking means may be configured such that in one orientation the attachment means is moveable along the base unit and in another orientation the attachment means is locked in a fixed position along the base unit. The locking means and attachment means may be held in a fixed relative position such that the movement of one results in corresponding movement of the other. Alternatively, the locking means may form an integral part of the attachment means.

[0050] In one embodiment, the base unit includes a profiled slot and the locking means comprises a bolt having a semi-circular cut-out at one side thereof such that in one orientation the bolt is permitted to travel along the profiled slot and in another orientation the bolt is held in a fixed position in the profiled slot. The profiled slot may be generally longitudinal and include a plurality of semi-circular cut-outs along one side thereof.

[0051] The attachment means may be configured such that the locking means is orientated into its locked position under the influence of gravity. Thus, the attachment means can be moved by a user acting against gravity, for example by rotating the attachment means to a horizontal rather than a vertical orientation so as to unlock the locking means. The attachment means can then be slid along the base unit to a desired position and thereafter rotated back to a locked (e.g. vertical) position for subsequent attachment to a support/containment means. The fact that the attachment means rotates to a substantially vertical position under gravity can help to hold the containment means close to the support means so as to minimise any rattling between these two components when it is windy, for example.

[0052] The base unit may be constituted by a U-shaped channel configured to be bolted or welded onto a support post.

Brief Description of the Drawings

[0053] Embodiments of the various aspects of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:-

Figure 1 shows part of an edge protection system in accordance to the present invention;
Figure 2 shows a fixing means of the edge protection system shown in Figure 1;
Figure 3 shows an intermediate element of the edge protection system shown in Figure 1;
Figure 4 shows an enlarged view of one of the fixing means and intermediate elements of Figure 1;
Figure 5 shows a cross-sectional view of the fixing means and intermediate element of Figure 4, taken along line AA;
Figure 6 shows a barrier for use with the part of the edge protection system shown in Figure 1;
Figure 7A shows a view similar to that of Figure 1 but with the barrier of Figure 6 being located on two of the fixing means;
Figure 7B shows an enlarged view of part of the barrier and one of the fixing means of Figure 7A;
Figure 8A shows a barrier and a fixing means attached to an alternative base;
Figure 8B shows an enlarged view of the fixing means and base of Figure 8A;
Figure 9 shows a cross-sectional view taken along line BB of Figure 8A;
Figure 10A shows an additional barrier for use with

the part of the edge protection system shown in Figure 1;

Figure 10B shows an enlarged view of a part of the additional barrier of Figure 10A, including a coupling means;

Figure 11 shows an enlarged view of the coupling means of Figures 10A and 10B;

Figure 12A shows a view similar to that of Figure 7A but with an additional barrier of Figure 10A located on one of the fixing means;

Figure 12B shows an enlarged view of part of the edge protection system shown in Figure 12A, showing the location of the additional barrier on the fixing means;

Figure 12C shows an enlarged view of part of the edge protection system shown in Figure 12A, showing the additional barrier being coupled to the barrier;

Figure 13 shows a side view of a coupler for use in the edge protection system shown in Figure 12A;

Figure 14A shows a view similar to that of Figure 12A but with the additional barrier coupled to the barrier and the coupler of Figure 13 located on the additional barrier;

Figure 14B shows an enlarged view of part of the edge protection system shown in Figure 14A, showing the coupler on the additional barrier;

Figure 15A shows a view similar to that of Figure 14A but with a further additional barrier being coupled to the coupler on the additional barrier;

Figure 15B shows an enlarged view of part of the edge protection system shown in Figure 15A, showing the location of the further additional barrier on a fixing means;

Figure 15C shows an enlarged view of part of the edge protection system shown in Figure 15A, showing the further additional barrier being coupled to the coupler;

Figure 16 shows a view similar to that of Figure 15A but with the further additional barrier coupled to the coupler to complete the edge protection system;

Figure 17A shows a view similar to that of Figure 16 but with mesh panels attached to the edge protection system;

Figure 17B shows an enlarged view of part of the edge protection system shown in Figure 17A, showing part of the coupler and illustrating a measuring means on said coupler;

Figure 18 shows a view similar to that of Figure 17A but looking at the edge protection system from the opposite (front) side;

Figure 19A shows a cross-sectional view taken along line CC of Figure 18;

Figure 19B shows an enlarged view of the centre portion of Figure 19A, showing the relative locations of each part of the edge protection system;

Figure 20 shows a barrier in accordance with a second embodiment not forming part of the present invention;

Figure 21 shows an edge protection system including five barriers as shown in Figure 20 mounted on a base similar to that shown in Figure 1;

Figure 22 shows an enlarged view of one end of the edge protection system shown in Figure 21;

Figure 23A shows an end view of the other end of the edge protection system shown in Figure 21, with a mesh panel attached thereto;

Figure 23B shows an enlarged view of Figure 23A showing an attachment means in more detail;

Figure 24 shows a view similar to that of Figure 23A but with a second mesh panel fitted;

Figure 25 shows a view similar to that of Figure 21 but with five mesh panels fitted to span the length of the base;

Figure 26 shows an enlarged view of one end of the edge protection system shown in Figure 25 but with a supplementary mesh panel being fitted;

Figure 27A shows a view similar to that of Figure 26 but with the supplementary mesh panel in place;

Figure 27B shows an enlarged view of Figure 27A showing the attachment of the supplementary mesh panel in more detail;

Figure 28 shows a view similar to Figure 25 but with two supplementary mesh panels fitted;

Figure 29 shows a view similar to Figure 28 but with five supplementary mesh panels fitted to span the length of the base;

Figure 30A shows a view similar to that of Figure 29 but with the second mesh panel lifted to allow local access through the edge protection system;

Figure 30B shows an enlarged view of Figure 30A showing the lifted mesh panel and local access area in more detail;

Figure 31A shows a front view of a barrier for an edge protection system including two adjustment devices according to an embodiment not forming part of the present invention;

Figure 31B shows a front perspective view of the barrier of Figure 31A, showing the adjustment device in more detail;

Figure 32 shows an enlarged perspective view of one of the adjustment devices shown in Figures 31A and 31B;

Figure 33A shows a side view of the adjustment device of Figure 32 in isolation;

Figure 33B shows a first side perspective view of the adjustment device of Figure 33A;

Figure 33C shows a second side perspective view of the adjustment device of Figure 33A, taken from the opposite side to that shown in Figure 33B;

Figure 34A shows a side perspective view of a locking bolt, as employed in the adjustment devices of the Figures 31A to 33C;

Figure 34B shows a side view of the locking bolt of Figure 34A;

Figure 35 shows a side perspective view of a post for use in embodiments not forming part of the

present invention;
Figure 36A shows the bottom end of the post of Figure 35 being inserted into the top of one of the upright posts in the barrier of Figures 31A and 31B;
Figure 36B shows another view similar to that shown in Figure 36A wherein the post is tethered to the barrier;
Figure 37 shows a view of the anti-lodge hook on the post of Figure 35, securing a mesh barrier to the post;
Figure 38 shows a perspective view of an alternative barrier for an edge protection system according to an embodiment not forming part of the present invention;
Figure 39 shows a perspective view of a lower mesh barrier for an edge protection system according to an embodiment not forming part of the present invention;
Figure 40 shows a perspective view of an upper mesh barrier for an edge protection system according to an embodiment not forming part of the present invention;
Figure 41A shows a front view of the barrier of Figure 38;
Figure 41B shows an enlarged front view of the lower end of one of the uprights of the barrier in Figure 41A;
Figure 41C shows an enlarged perspective view of the lower end of one of the uprights of the barrier in Figure 41A, showing a reinforcement therein;
Figure 42A shows a perspective view of the barrier of Figures 38 and 41A being removed from intermediate elements of a fixing means provided on a base, after a concrete slab has been cast thereon;
Figure 42B shows the intermediate elements being removed from the base;
Figure 42C shows the base of Figure 42B after void plugs have been inserted into the holes remaining in the concrete slab;
Figure 43 shows a horizontal cross-sectional view through the end of the barrier of
Figures 38 and 41A when inserted into the fixing means and intermediate element as shown in Figures 2 and 3;
Figure 44 shows a side perspective view of a void plug as used in Figure 42C;
Figure 45 shows a vertical cross-sectional view through the concrete slab and fixing means of Figure 42C;
Figure 46 shows a perspective view of an alternative fixing means for the lower end of the barrier of Figures 38 and 41A;
Figure 47A shows a perspective view of a material handing unit for use with an edge protection system not forming part of the present invention;
Figure 47B shows the material handling unit of Figure 47A loaded with components of the edge protection system;
Figure 48A shows a side view of an edge protection system in accordance with an embodiment not forming part of the present invention, prior to the casting of a concrete slab;
Figure 48B shows a side view of the edge protection system of figure 48A including the additional post of Figure 35 and the upper mesh barrier of Figure 40;
Figure 49A shows a side view of the edge protection system of Figure 48A, after a concrete slab has been cast and showing the lower mesh barrier raised to accommodate the slab; and
Figure 49B shows a side view of the edge protection system of Figure 48B, after a concrete slab has been cast and showing the lower mesh barrier raised to accommodate the slab.

Detailed Description of Certain Embodiments

[0054] With reference to Figures 1 to 5, there is illustrated part of an edge protection system 10 in accordance with the present invention. The part of the edge protection system 10 shown in these Figures comprises a fixing means in the form of a tubular steel socket 12 and an intermediate element constituted by a tubular plastic sleeve 14 which is approximately twice as long as the socket 12. The sleeve 14 is sized to fit snugly within the socket 12 to provide a hollow channel 16 therethrough. Prior to insertion of the sleeve 14, the socket 12 is welded in an upright position to a base 18. In this particular embodiment, the base 18 is a horizontal steel I-beam 20 for use in forming an edge of a working platform in a scaffolding construction. The I-beam 20 is located between two vertical I-beam supports 22, also made from steel.

[0055] Although, the I-beam 20 is shown at a position approximately one third of the way up the supports 22, it will be understood that when the edge protection system 10 is being assembled on the I-beam 20 it is being assembled at a height which can be easily reached from the ground.

[0056] In Figure 1 four sockets 12, with respective sleeves 14 are provided on the I-beam 20. The first socket 12 is provided at a first end 24 of the I-beam 20, adjacent the first support 22. The second socket 12 is provided a pre-determined distance 'D' along the I-beam 20 from the first socket 12 - the distance 'D' being governed by the length of each barrier, as will be described later. The third socket 12 is then provided at the same distance 'D' from the second socket 12. Finally, the fourth socket 12 is provided at a second end 26 of the I-beam 20, adjacent the second support 22. Note that the distance between the third and fourth sockets 12 is less than the distance 'D'. If the I-beam 20 was longer than shown, more sockets 12 would be provided, each spaced a distance 'D' from the next, until the distance from one socket 12 to the second end 26 of the I-beam 20 is less than the distance 'D' - in which case the final socket 12 is always placed at the second end 26 of the I-beam 20. The position for each socket 12 may be indicated along the length of the I-beam 20.

[0057] Figure 6 shows a first barrier 30 for use with the part of the edge protection system 10 shown in Figure 1. The first barrier 30 comprises two horizontally spaced apart vertical uprights 32 of substantially similar height. The upper ends 33 of the uprights 32 curve inwardly and connect via an upper horizontal bar 34. Approximately a third of the distance up from the lower ends 35 of the uprights 32, a lower horizontal bar 36 spans between the uprights 32. Midway between the upper and lower horizontal bars 34, 36, an intermediate bar 38 is provided between the two uprights 32. The first barrier 30 is constructed from hollow metal tubing. The lower end 35 of each upright 32 constitutes, in use, a plug for a respective socket 12 and sleeve 14, as illustrated in Figures 7A and 7B. Thus, in use, the lower ends 35 of the first barrier 30 are located into the respective first and second sockets 12. The sleeves 14 are ensure a snug fit between the lower ends 35 and the sockets 12, whilst also facilitating easier insertion and removal of the first barrier 30 from the sockets 12.

[0058] As illustrated in Figures 8A, 8B and 9, the sockets 12 may be secured to an alternative base 40. In this embodiment, the base 40 comprises a corrugated horizontal panel 42 and an upright planar guard rail 44. The guard rail extends vertically upwardly from one side of the panel 42 and includes an in-turned lip 46 along its top edge. In use, the guard rail 44 terminates below the lower horizontal bar 36 of the first barrier 30 and the socket 12 is welded to the panel 42 between adjacent corrugations 48.

[0059] Figures 10A and 10B show a (second) additional barrier 50 for use with the part of the edge protection system 10 shown in Figures 1 and 7A. The construction of the additional barrier 50 is similar to that of the first barrier 30 and so like numerals will be used where appropriate. The main difference between the first barrier 30 and the additional barrier 50 is that the additional barrier only has one upright 32 having a lower end 35 configured for engagement in a socket 12. At the other end of the additional barrier 50, a connecting upright 52 is provided in place of another upright 32. The connecting upright 52 is similar to the upright 32 but only extends between the upper horizontal bar 34 and the lower horizontal bar 36 (i.e. is doe not include a lower end 35 configured for engagement in a socket 12). On the connecting upright 52, two coupling means are provided in the form of clasps 54. One of the clasps 54 is provided close to the upper horizontal bar 34 while the other of the clasps 54 is provided close to the lower horizontal bar 36. The clasps 54 are provided to couple the additional barrier 50 to the first barrier 30, as will be described below. In addition to the above it should be noted that the length of the additional barrier 50 is slightly less than that of the first barrier 30. Whilst the distance between the uprights 32 of the first barrier 30 corresponds to the distance 'D' between the sockets 12, as shown in Figure 7A, the distance between the upright 32 and connecting upright 52 of the additional barrier 50 is less than 'D', as indicated in Figure 10A. In fact, the distance between the upright 32 and the clasps 54 of the additional barrier 50 corresponds to the distance 'D'. This allows for the clasps 54 to be attached to one of the uprights 32 of the first barrier 30 when it is located in a respective socket 12 and the upright 32 of the additional barrier 50 is located in the next adjacent socket 12, as will be described more fully below.

[0060] Figure 11 shows an enlarged view of one of the clasps 54. The clasp 54 includes a concave arm 56 configured to wrap part-way around the upright 32 of the first barrier 30 once snap-fitted thereto. The clasp 54 also includes a spring-loaded part 58 at one end of the concave arm 56. The spring-loaded part 58 is configured such that in its rest position it extends part-way around the upright 32 so as to grip onto it. To release the upright 32 from the clasp 54, the spring-loaded part 58 can be manually moved away from the upright 32 by applying pressure against the spring bias. Accordingly, the clasps 54 serve to couple the end of the additional barrier 50 to the end of the first barrier 30. As will be described below, the clasps 54 may also be employed to couple one additional barrier 50 to another additional barrier 50. It should be noted that no additional tools are required to operate the clasps 54 and so the barriers 30, 50 can be coupled together (and uncoupled) via manual manipulation alone.

[0061] Figures 12A, B and C illustrate the attachment of an additional barrier 50 to the edge protection system 10 of Figure 7A, once the first barrier 30 has been positioned. Note, as shown, the additional barrier 50 is viewed from the opposite side to that in Figures 10A and B. Firstly, as shown in Figure 12B, the upright 32 of the additional barrier 50 is located in the socket 12 and sleeve 14 closest to the free end of the first barrier 30. The additional barrier 50 is then rotated about this pivot point to bring the connecting upright 52 adjacent to the free upright 32 of the first barrier 30 whereupon pushing the additional barrier 50 into line with the first barrier 30 forces the clasps 54 (located on the connecting upright 52) to click into engagement with the upright 32, thereby coupling the barriers 30, 50 end to end.

[0062] Figure 13 shows a coupler 60 for use in the edge protection system 10 shown in Figure 12A. The coupler 60 comprises a post 62 of length slightly greater than the distance between the upper and lower horizontal bars 34, 36 of the additional barrier 50. At a lower end of the post 62 is a lower hook 64 of a similar form to the concave arm 56 of Figure 11. The lower hook 64 is arranged to clamp down on the lower horizontal bar 36. Approximately half way up the post 62, from the lower end, is an upper hook 66 also of a similar form to the concave arm 56 of Figure 11. The upper hook 66 is arranged to clamp from below, the intermediate bar 38. Thus, the post 62 is attachable to the additional barrier 50 (or the first barrier 30) via the upper and lower hooks 66, 64. It should be noted that the position of the coupler 60 along the additional (or first) barrier 50 can be chosen to suit the desired

degree of overlap, as will be described below.

[0063] Figures 14A and B show the edge protection system 10 of Figure 12A but with the additional barrier 50 coupled to the first barrier 30 and the coupler 60 of Figure 13 attached mid-way along the length of the additional barrier 50.

[0064] Figures 15A, B and C show the edge protection system 10 of Figure 14A but with a further (third) additional barrier 50 being coupled to the coupler 60 on the (second) additional barrier 50. As above, the upright 32 of the further additional barrier 50 is located in the socket 12 and sleeve 14 closest to the free end of the additional barrier 50 (in this case, the socket 12 and sleeve 14 located at the second end 26 of the I-beam 20, which is less than the distance 'D' from the next adjacent socket 12). The further additional barrier 50 is then rotated about this pivot point to bring the connecting upright 52 adjacent to the additional barrier 50. In this position, part (approximately half) of the further additional barrier 50 is adjacent part (approximately half) of the additional barrier 50 (i.e. their closest ends overlap). As the coupler 60 is positioned approximately half way along the additional barrier 50, it is close to the clasps 54 located on the connecting upright 52 of the further additional barrier 50. Pushing the further additional barrier 50 into juxtaposition with the additional barrier 50 forces the clasps 54 to click into engagement with the coupler 60 to thereby couple the additional barriers 50, 50 in an overlapping configuration, as shown in Figure 16.

[0065] In use, the edge protection system 10 shown in Figure 16 can be raised to a working height on a scaffolding structure or the like. In so doing, a barrier is provided all the while the structure is being constructed, thereby reducing the risk of a worker falling from height.

[0066] It will be noted that the open configuration of the first and additional barriers 30, 50 allows safe access beyond the confines of the edge protection system 10. However, if such access is not required steel mesh panels 70 can be located on the barrier to provide increased containment, as shown in Figure 17A. The mesh panels 70 are attached to the first and additional barriers 30, 50 by way of linking posts 72. The linking posts 72 are attached to the barriers 30, 50 via clasps (not shown but similar to those in Figure 11). Up-turned hooks (not shown) are provided on the linking posts 72 and upon which the mesh panels 70 are hung.

[0067] Figure 17B shows part of the coupler 60, which includes a measuring means in the form of a scale 74. This can be useful when adjusting the height of the barriers 30, 50 or mesh panels 70.

[0068] Figure 18 shows the edge protection system 10 of Figure 17A from the opposite (front) side and Figures 19A and B show a cross-sectional view taken along line CC of Figure 18, showing the relative locations of each part of the edge protection system 10.

[0069] Figures 20 to 30B illustrate a second embodiment not forming part of the present invention. Figure 20 shows a barrier 80 for use in an edge protection system 81 similar to that shown in Figure 1 but which will be described in more detail in relation to Figure 21.

[0070] The barrier 80 is constructed from hollow metal tubing with a substantially square cross-section and comprises a first upright 82 and a second upright 84 of substantially similar height. A laterally extending body 86 extends from the top of each upright 82, 84 to approximately two thirds of the distance down the uprights 82, 84. The uprights 82, 84 are horizontally spaced along the body 86 and are slidably moveable along the lateral length of the body 86. The lower ends 88, 90 of the uprights 82, 84 constitute, in use, plugs for engagement in complementary sockets 12 and sleeves 14, as illustrated in Figure 21. Thus, in use, the lower ends 88, 90 of the barrier 80 are located into respective adjacent sockets 12 and sleeves 14.

[0071] In this embodiment, the body 86 comprises an upper and a lower horizontal bar 92, 94 and an intermediate horizontal bar 96 provided midway therebetween. A vertical support post 98 is provided between the upper and lower horizontal bars 92, 94 and is fixedly attached by pins (not shown) to the centres of the upper, lower and intermediate bars 92, 94, 96 to give the body 86 a rigid structure. The support post 98 also minimises the deflection of the upper, lower and intermediate horizontal bars 92, 94, 96. In the embodiment shown, the support post 98 is provided such that the maximum cantilever length of the upper, lower and intermediate horizontal bars 92, 94, 96 is 1m (although in other applications this may be different, e.g. 0.5m).

[0072] Metal Sleeves 100 are provided at the points where the first and second uprights 82, 84 overlap with the upper, lower and intermediate bars 92, 94, 96 of the body 86. The metal sleeves 100 are configured to allow the first and second uprights 82, 84 to slide along the length of the upper, lower and intermediate bars 92, 94, 96 so as to adjust their relative position along the length of the body 86. A locking means in the form of a screw 102 is provided on at least one of the metal sleeves 100 of each upright 82, 84 to fix the position of the uprights 82, 84 with respect to the body 86.

[0073] Also provided on each upright 82, 84 are two vertically spaced apart attachment means in the form of carabiners 104. The carabiners 104 are pivotally mounted on the uprights 82, 84 and are configured for attachment to a mesh panel as will be explained below.

[0074] With reference to Figure 21, it will appreciated that the barrier 80 can be employed in an edge protection system 81 similar to that shown in Figure 1 but in which nine sockets 12, provided with respective sleeves 14, are welded onto the base I-beam 20 between adjacent vertical I-beam supports 22. The spacing between adjacent sockets 12 is constant in this embodiment (in use they are generally 1m apart but for shorter beams they may be 0.85m apart).

[0075] A number of barriers 80 are supplied with the uprights 82, 84 locked a set distance (e.g. 1m) apart and with the support post 98 provided midway between the

uprights 82, 84. Each barrier 80 is then mounted with the lower ends 88, 90 of its uprights 82, 84 in adjacent sockets 12 such that the bodies 86 are positioned end to end where possible. If the uprights 82, 84 do not align exactly with the sockets 12 one or both uprights 82, 84 can be slid to the required position before being mounted in the sockets 12 as illustrated in Figure 21. Thus, no hot works are required on site for fixing or adjusting the positions of the sockets 12.

[0076] In an economic system, the each barrier 80 is mounted such that the end of the body 86 of one barrier 80 abuts the end of the body 86 of the next barrier 80. However, it is also possible to overlap the bodies 86 and this is required when the gap to be filled by the edge protection system 81 is not an exact multiple of barriers 80. Thus, as shown in Figure 22, the end barrier 80 can be rotated through 180 degrees with respect to the orientation of the next adjacent barrier 80 to allow room for the bodies 86 of each barrier 80 to overlap. The relative positions of the uprights 82, 84 with respect to the body 86 can then be adjusted such that when mounted in the sockets 12, a larger proportion of the body 86 extends away from the nearest vertical I-beam support 22 than towards it. This ensures that the edge protection system 81 extends the full length of the beam 20.

[0077] In use, it would now be possible for the edge protection system 81 to be raised to height and work commenced on the structure. However, it is also possible to fit an optional mesh panel 110 to the edge protection system 81 for additional containment, as illustrated in Figure 23A. The mesh panel 110 comprises a rectangular array constructed from a number of vertical and horizontal metal rods 112, 114 with a solid elongate rectangular toe board 106 provided along approximately its lower fifth. The gaps created by the array are approximately 100x200mm.

[0078] As shown in more detail in Figure 23B, the mesh panel 110 is attached to the barrier 80 via the carabiners 104 which clasp hold of an adjacent horizontal metal rod 114 of the array. The carabiners 104 may be configured to rotate through any given range of movement (e.g. 90°, 180° or 360°) with respect to the barrier 80.

[0079] As illustrated by Figures 24 and 25 a number of mesh panels 110 can be placed end to end and attached to adjacent barriers 80 via respective carabiners 104 to provide improved containment along the length of the edge protection system 81. Where there is not enough room at the end of the beam 20 to place another mesh panel 110 end to end, it can overlap with the previous mesh panel 110 to ensure that no gaps are left.

[0080] In addition to the mesh panel 110, a supplementary (top-up) mesh panel 120 can be provided to increase the height of the mesh to, say, 2m. Figures 26, 27A and 27B illustrate attachment of one supplementary mesh panel 120 to the edge protection system 81. The supplementary mesh panel 120 is of a similar size to that of the mesh panel 110 but does not include the toe board 106. Accordingly, the supplementary mesh panel 120 simply comprises a rectangular array constructed from a number of vertical and horizontal metal rods 122, 124 similar to those of the mesh panel 110. In addition, the supplementary mesh panel 120 includes an anti-roll device constituted by two spaced apart U-shaped stirrups 126 depending from the bottom horizontal metal rod 124. As best illustrated in Figure 27B, the stirrups 126 are offset from the base of the supplementary mesh panel 120 so that they can be tucked behind a horizontal metal rod 114 of a mesh panel 110 mounted therebelow - with the remainder of the lower portion of supplementary mesh panel 120 being provided in front of the mesh panel 110, the stirrups 126 prevent the supplementary barrier from rotating backwards about a horizontal axis when in use. Moreover, the uppermost carabiners 104 can also be attached to an adjacent horizontal metal bar 124 of the supplementary mesh panel 120 to secure it in place.

[0081] As for the mesh panels 110, a number of supplementary mesh panels 120 can be placed end to end and attached to adjacent barriers 80 via respective carabiners 104 to provide improved containment along the length of the edge protection system 81, as shown in Figures 28 and 29. Where there is not enough room at the end of the beam 20 to place another supplementary mesh panel 120 end to end, it can overlap with the previous supplementary mesh panel 120 to ensure that no gaps are left.

[0082] As illustrated in Figures 30A and B, individual mesh panels 110 can be lifted to provide local access through the edge protection system 81 when required (e.g. for fixing cladding brackets). This is achieved by unclipping the mesh panel 110 concerned from the respective carabiners 104, lifting the mesh panel 110 to the required height, and re-attaching the carabiners 104 to the next adjacent (i.e. lower) horizontal metal bar 114. In some embodiments this can provide a work-through area 130 of approximately 550mm^2.

[0083] In certain embodiments, the barrier 80 and/or the mesh panels 110, 120 are made from steel or aluminium. It is also possible to supply 40m of edge protection 81 according to the present invention by supplying a stack of barriers 80 2m long by 1.4m wide by 0.7m high for transporting to the required site. In addition, 140m of mesh panel 110, 120 can be provided in a 0.7m high stack for transporting to the required site.

[0084] With reference to Figures 31A and 31B, there is illustrated part of an edge protection system 210 in accordance with an embodiment not forming part of the present invention. The part of the edge protection system 210 shown in these Figures comprises a barrier 212 which is similar to that described above in relation to Figure 20 but is now fitted with two adjustment devices 214 according to an embodiment of the present invention.

[0085] As described above the barrier 212 is constructed from hollow metal tubing with a substantially square cross-section and comprises a first upright 82 and a second upright 84 of substantially similar height. A laterally extending body 86 extends from the top of each upright

82, 84 to approximately two thirds of the distance down the uprights 82, 84. The uprights 82, 84 are horizontally spaced along the body 86 and are slidably moveable along the lateral length of the body 86. The lower ends 88, 90 of the uprights 82, 84 constitute, in use, plugs for engagement in complementary support sockets and sleeves (not shown). Thus, in use, the lower ends 88, 90 of the barrier 212 are located into respective adjacent sockets and sleeves provided on a base element (not shown).

[0086] In the embodiment shown, the body 86 comprises an upper and a lower horizontal bar 92, 94 and an intermediate horizontal bar 96 provided midway therebetween. A vertical support post 98 is provided between the upper and lower horizontal bars 92, 94 and is fixedly attached by pins (not shown) to the centres of the upper, lower and intermediate bars 92, 94, 96 to give the body 86 a rigid structure. The support post 98 also minimises the deflection of the upper, lower and intermediate horizontal bars 92, 94, 96. In the embodiment shown, the support post 98 is provided such that the maximum cantilever length of the upper, lower and intermediate horizontal bars 92, 94, 96 is 1m (although in other applications this may be different, e.g. 0.5m).

[0087] Metal Sleeves 100 are provided at the points where the first and second uprights 82, 84 overlap with the upper, lower and intermediate bars 92, 94, 96 of the body 86. The metal sleeves 100 are configured to allow the first and second uprights 82, 84 to slide along the length of the upper, lower and intermediate bars 92, 94, 96 so as to adjust their relative position along the length of the body 86. A locking element in the form of a screw 102 is provided on at least one of the metal sleeves 100 of each upright 82, 84 to fix the position of the uprights 82, 84 with respect to the body 86. A stop nut (not shown) may also be provided at the ends of the horizontal bars 92, 94, 96 to prevent the uprights 82, 84 from sliding completely off the body 86.

[0088] The adjustment devices 214 are provided on the inner facing portions at the top of each upright 82, 84 and these will be described in more detail below.

[0089] Also provided in this particular embodiment is an additional attachment means in the form of a carabiner 204 which is rotatably mounted on the support post 98 between the lower and intermediate horizontal bars 94, 96. Whilst the carabiner 204 is configured for attachment to a mesh panel as will be explained below, unlike with the adjustment means 214, this particular carabiner 204 is not moveable with respect to the barrier 212.

[0090] As can be seen from Figures 32, 33A, 33B and 33C the adjustment device 214 comprises a base unit in the form of a U-shaped channel 220 which can be welded onto the barrier 212 with its sides 222 projecting towards the upright 82, 84 to which it is attached and its base 224 projecting outwardly there-from. A profiled slot 226 is provided in the base 224 and includes a generally vertically extending portion 228 having, in this case, five semi-circular cut-outs 230 along one side thereof.

[0091] An attachment means in the form of a carabiner 232 with a spring-loaded clasp 234 is moveably mounted in the slot 226 by a roll pin 236 which connects the carabiner 232 to a locking means 238. The roll pin 236 is formed from an elongate metal strip which is rolled into a cylindrical form with a gap along one side which permits the pin 236 to be compressed into a hole and then to expand to fix the pin 236 in position.

[0092] The locking means 238 is shown in detail in Figures 34A and 34B and comprises a bolt 246 with a hollow substantially cylindrical shank 248 and enlarged head 250. Beneath the enlarged head 250 there is provided a semi-circular cut-out 252 in the shank 248. Also provided towards the centre of the shank 248 is a transverse hole 254. In use, the head 250 of the bolt 246 is provided within the U-shaped channel 220 with the shank 248 projecting through the slot 226 and then through a generally circular hole 244 provided at one end of the carabiner 232. The hole 254 in the bolt 246 is aligned with corresponding holes 256 in the parts of the carabiner 232 which surround the bolt 246 and the roll pin 236 is inserted through the holes 254 and 256 so as to couple the carabiner 232 to the locking means 238.

[0093] It will be understood that the carabiner 232 will be fixedly attached to the locking means 238 in a predetermined configured so as to operate in the manner described below.

[0094] In the embodiment shown, a washer 242 is provided between the base 224 and the carabiner 232 to act as a spacer and serves to permit the carabiner 232 and locking means 238 to rotate relative to the base 224.

[0095] In an alternative embodiment (not shown), the carabiner 232, roll pin 236 and locking means 238 can be integrally formed.

[0096] Although in the embodiment shown the carabiner 232 is positioned horizontally, it will be understood that under normal operation, the carabiner 232 will swing to a vertical position under gravity. In such a vertical position the bolt 246 will rotate such that the slot 252 will not be aligned to permit the carabiner 232 to be slid vertically along the slot 226. However, when the carabiner 232 is rotated to a horizontal position, as shown, the slot 252 will be aligned within the slot 226 to permit the carabiner 232 to be repositioned. Allowing the carabiner 232 to fall back to its vertical position when aligned with one of the other semi-circular cut-outs 230 will then lock the carabiner 232 in its new position in the slot 226. In this way, the carabiner 232 can be selectively positioned with respect to the base 226 and barrier 212 for subsequent attachment of a containment means in the form of a mesh panel (not shown).

[0097] It will be noted that the open configuration of the barrier 212 allows safe access beyond the confines of the edge protection system 210. However, when such access is not required steel mesh panels (not shown) can be located on the barrier 212 to provide increased containment. As described above, a mesh panel can be attached to the barrier 212 via the carabiners 204 and

232 since these can clasp hold of an adjacent horizontal metal rod of the mesh panel. Furthermore, the present invention can be used to adjust the height of such a mesh panel (relative to the barrier 212) by simply re-positioning the carabiners 232 as described above and re-attaching the mesh panels at the new height. Accordingly, the height of an edge protection system can be quickly and easily adjusted to compensate for the height of a concrete slab once cast.

[0098] It is also noted that the various aspects of the invention may be employed in conjunction with a debris net. The debris net may be secured to a soffit of the building being constructed or repaired via an eye bolt which is screwed into a V-nut provided in an inwardly inclined channel in the soffit. One or more weights may be attached to the base of the net to ensure that it hangs approximately vertically and is not inadvertently repositioned to reduce containment. The net may be configured such that openings can be selectively provided where greater access beyond the net is required.

[0099] Various aspects of the present invention may also be used in conjunction with a safety post in accordance with the Applicant's co-pending patent application number EP1820920. A post 260 in accordance with an embodiment of that invention is shown in Figure 35 and comprises an elongate hollow tubular member 262 having a substantially square cross-section. Towards a lower end of the post 260 the outer dimensions of the tubular member 262 are reduced to form an insert 264. Projecting from at least one side of the insert 264 is a spring-biased locking member 266. As shown in Figures 36A and 36B, the locking member 266 is arranged to protrude into a complementary hole 268 in an upper portion of an upright 88 of a barrier 210 (such as that shown in Figures 31A and 31B), so as to provide positive engagement when the insert 264 is inserted into the top of the upright 88. A release button 269 is provided above the insert and is configured such that when the release button 269 is depressed, the locking member 266 is retracted into the insert 264 to allow the post 260 to be detached from the upright 88.

[0100] An L-shaped bracket 270 is provided above the insert 264 for supporting an upper mesh barrier (not shown) of the type described in relation to Figure 26. An anti-dislodge hook 272 is provided towards an upper end of the post 260, when in use.

[0101] As shown in Figure 36B, a tether 274 may be provided between the post 260 and the barrier 210 to secure the two components together at least while the post 260 is being inserted or removed from the barrier 210. In this embodiment, the tether 274 comprises a rope tied around the post 260 and releasably secured to the metal sleeve 100 of the barrier 210 via a plastic T-shaped anchor 276 which is threaded through a metal hook 278. In other embodiments, the tether may be integrated with one of the barrier 210 or the post 260.

[0102] Figure 37 shows an enlarged view of the anti-dislodge hook 272 of the post 260 of Figure 35, securing a mesh barrier 120 to the post 260. The anti-dislodge hook 272 comprises an upwardly sloping support arm 280 having a vertical lip 282 at a free end thereof and a downwardly sloping retaining arm 284 arranged to terminate below the height of the lip 282 between the lip 282 and the tubular member 262. Thus, in use, a horizontal rod 124 of the mesh barrier 120 is passed over the lip 282 and located on the support arm 280 such that the retaining arm 284 prevents the mesh barrier 120 from being inadvertently detached from the post 260, for example, by simply lifting the mesh barrier 120 straight upwardly. Instead, in order to remove the mesh barrier 120, the retained horizontal rod 124 must be navigated through the gap between the retaining arm 284 and the lip 282.

[0103] Figure 38 shows a perspective view of an alternative barrier 290 for an edge protection system according to an embodiment not forming part of the present invention. The barrier 290 is substantially similar to the barrier 80 shown in Figure 20 and so like reference numerals will be employed where appropriate. In fact, the only significant differences between the barrier 80 and that shown in Figure 38 are that the present barrier 290 includes alternative adjustment units 292 on each of the first and second uprights 82, 84 and, as shown in more detail in Figures 41B and 41C, the lower portions of each of the first and second uprights 82, 84 are reinforced.

[0104] The adjustment units 292 are provided to allow the height of the carabiners 294 to be adjusted relative to the uprights 82, 84. This in turn may allow a lower mesh barrier 295 such as that shown in Figure 39 to be attached to the barrier 290 in a number of different positions or heights.

[0105] The adjustment unit 292 comprises a support 296 attached to the uprights 82, 84 at its upper and lower ends. Along the length of the support 296 there are provided a number of vertically spaced apart holes 298. A spring-pin slider plate 300 is mounted on the support 296 and is moveable there along. The carabiners 294 are rotatably mounted on the slider 300. The bias of the spring-pin slider plate 300 will be such that the plate is retained on the support at any height set. When the user wishes to adjust the height of the carabiner 294 they will pull the pin outwardly against the bias of the spring to allow the plate 300 to be slid to the new position. When the pin is released, it will locate through one of the adjacent holes 298 to again lock the plate 300 in position. Thus, no tools will be required for adjusting the height of the carabiners 294 and thereby adjusting the height of the mesh barrier 295.

[0106] A top up kit may be provided with at least one of the barriers 290 and at least one of the lower mesh barriers 295 and may include at least one post 260 in accordance with Figure 35 and at least one upper mesh barrier 302 as shown in Figure 40. It will be understood, that in such an embodiment, the edge protection system can be quickly and easily installed, adjusted and removed without the need for any tools.

[0107] Figures 41A, 41B and 41C show more detail of the lower end of one of the uprights 82 of the barrier 290. Accordingly, it can be seen that the upright 82 includes an inner tubular element 304 as a reinforcement or leg stiffener. Both the upright 82 and the tubular element 304 have square cross-sections, one fitting snugly inside the other. In a particular embodiment, a reinforcement is provided to ensure that the barrier 290 can withstand 100mph gusts of wind and meets relevant standards.

[0108] Figure 42A shows a perspective view of the barrier 290 of Figures 38 and 41A being removed from intermediate elements 14 of a fixing means (not shown) provided on a an I-beam base 20 in accordance with Figure 1, after a concrete slab 306 has been cast thereon. Figure 42B shows the intermediate elements 14 being removed from the base 20 and Figure 42C shows the concrete slab 306 after void plugs 308 have been inserted into the holes remaining in the concrete slab 306.

[0109] Figure 43 shows a horizontal cross-sectional view through the end of the barrier 290 of Figures 38 and 41A prior to removal of the barrier 290 from the fixing means 12 and intermediate elements 14 of Figure 42A. Thus, it can be seen that the square profiles of the upright 82 and reinforcement 304 fit tightly within the circular diameters of the plastic sleeve 14 and metal socket 12. It has been found that such an arrangement can reduce movement of the barrier 290 by approximately 30%. As described previously, the metal socket 12 will be completely enveloped by concrete when the slab 306 is cast but the plastic sleeve 14 will remain partly accessible so it that is can be removed from the socket after the uprights 82 have been removed, as shown in Figure 42B.

[0110] Naturally, this process will result in holes within the concrete slab 306. Traditionally, these holes would be filled in with further concrete but this is dangerous when there is no edge protection system in place. It also often results in concrete being splashed onto finished surfaces such as glazing which can be difficult and expensive to clean. In embodiments of the present invention these holes can be filled by the void plug 308 shown in Figure 44 which may be made of plastic or steel. The void plug 308 comprises a hollow cylindrical body 310 configured to fit snugly within the socket 12 plus an oversized lid 312 configured to rest on the top surface of the socket 12 and to lie approximately flush with the surrounding cast concrete slab 306 as illustrated in Figure 45. In practice, the void plug 308 will be made slightly larger than the hole it is designed to fill so that when it is forced into the hole (e.g. with a mallet) it forms a tight, friction fit and does not require any grouting. Accordingly, the void plug 308 can eliminate the need for 'wet works' to complete the concrete slab 306 - again, improving the safety of the workers and speeding up and simplifying the construction process.

[0111] Figure 46 shows a perspective view of an alternative fixing means 320 for the uprights 82, 84 of the barrier 290 of Figures 38 and 41A. The alternative fixing means 320 is substantially as described in the applicant's co-pending European patent application number EP 2,065,537. In this case, the fixing means 320 may be screwed directly into a cast concrete slab 306 as shown.

[0112] Figures 47A and 47B show perspective views of an unloaded and loaded material handing unit 330 for use with an edge protection. The material handing unit 330 comprises a cuboidal frame 332 having four feet 334 provided at the lower end of each corner post 336, two spaced-apart transverse base posts 338, opposed horizontal side bars 340 and two centre bars 342 extending between the horizontal side bars 340. Two handling hooks 344 are provided on each of the front and rear top posts 346 and further handling hooks 348 are provided on the centre bars 342.

[0113] In the embodiment shown, the frame 332 is approximately 1m wide, 1.2m deep and 2m tall. A material handing unit 330 of this type may have a maximum capacity of 65 lower barriers 295 (weighing a total of approximately 750kg), 65 upper barriers 302 (weighing a total of approximately 900kg) or 10 barriers 290 (weighing a total of approximately 260kg).

[0114] Figure 47B shows the material handling unit 330 of Figure 47A loaded with various components of an edge protection system. In this case, the unit 330 is carrying eight sets of components (each set comprising one barrier 290, one lower mesh barrier 295 and one upper mesh barrier 302) weighing a total of approximately 420kg. It will be understood that components will be loaded into the frame 332 from the sides while the centre bars 342 are not present. The centre bars 342 will then be fed through the frame 332 and components and secured to the side bars 340 to retain the components on the handling unit 330.

[0115] It will be noted that the material handling unit 330 has been designed so that two such units can be accommodated on a standard hoist platform when loaded.

[0116] Figure 48A shows a side view of an edge protection system in accordance with an embodiment not forming part of the present invention, prior to the casting of a concrete slab 306. In this case, the edge protection system comprises a barrier 290 mounted in a sleeve 14 within a socket 12 and having a mesh barrier 295 secured to the barrier 290 via carabiners 294 provided at a first (low) position with respect to the barrier 290. Figure 48B shows a view of the edge protection system of figure 48A including the additional post 260 of Figure 35 and the upper mesh barrier 302 of Figure 40.

[0117] Figure 49A shows a side view of the edge protection system of Figure 48A, after the concrete slab 306 has been cast and showing that the carabiner 294 and the lower mesh barrier 295 has been raised to accommodate the slab 306. Similarly, Figure 49B shows a side view of the edge protection system of Figure 48B, after the concrete slab 306 has been cast and showing that the carabiner 294 the lower mesh barrier 295 has been raised to accommodate the slab 306. It will be noted that the upper mesh barrier 302 remains in the same position

as in Figure 48B while the lower mesh barrier 295 is raised to overlap with the base of the upper mesh barrier 302 so as to allow concrete to be poured around the fixings 12. Accordingly, a high level of containment can be maintained even when casting concrete slabs 306.

[0118] For completeness, the height of the edge protection system in Figures 48A and 48B may be approximately 1.15m and the height of the of the extended edge protection system in Figures 49A and 49B may be approximately 2.6m to 2.8m

[0119] The various aspects of the present invention can offer many advantages to many trades. For example, the steel erector's job is simplified by requiring only a few standard components that can be adjusted to fit any space. In addition, the acts of metal decking, laying concrete, cladding and removing the edge protection are also facilitated by aspects of the invention making the whole process safer and more efficient.

[0120] It will be appreciated by persons skilled in the art that various modifications may be made to the above-described embodiments while falling within the scope of the appended claims. For example, whilst the above discussion has been concerned with an edge protection system for use as a temporary guard rail for a scaffolding system, the invention is equally applicable to other edge protection systems such as those required on the ground for fencing or crowd control.

Claims

1. An edge protection system (10) for a base (20, 40), the edge protection system comprising:

   a fixing means (12, 14) securable to or integral with said base (20,40), and
   a barrier (30) comprising at least two horizontally spaced apart uprights (32) with an upper and a lower horizontal element (34, 36) spanning therebetween,
   at least one adjacent, additional barrier (50) and respective fixing means (12,14), said barrier (30) being configured for releasable engagement with the fixing means (12,14) to retain the barrier (30) on said base, when said base is raised to a working position;
   wherein coupling means (54, 64,66) are provided to couple the barriers (30,50) together; and
   wherein a coupler (60) is provided to allow the additional barrier (50) to be coupled to the barrier (30) with a degree of overlap therebetween;
   the coupler (60) being attachable to the barrier (30) at any point along the length of the barrier and wherein the coupler is configured to secure the additional barrier to said barrier;
   the coupler (60) comprises a post (62) having a first series of coupling means (64,66) configured for attaching the post to the barrier; **characterized in that** a second series of coupling means (54), configured for attaching the additional barrier (50) to the post (62) is provided on the additional barrier (50).

2. The edge protection system according to claim 1 wherein a beam, a slab, a panel or a pre-manufactured floor element constitutes the base (20, 40).

3. The edge protection system according to claim 1 or claim 2 wherein the fixing means (12, 14) is fixedly secured to the base (20,40).

4. The edge protection system according to any preceding claim wherein the fixing means (12, 14) comprises a socket (12) or a plug configured for engagement with a part of the barrier that constitutes a complementary plug or socket (35).

5. The edge protection system according to any preceding claim, wherein the socket (12, 35) is in the form of a cylindrical tube and the plug (12, 35) is in the form of a cylindrical rod.

6. The edge protection system according to any preceding claim wherein an intermediate element (14) is provided between the fixing means (12) and barrier.

7. The edge protection system according to any preceding claim, wherein the barrier (30) comprises at least one opening configured to allow access there through.

8. An edge protection system according to any preceding claim wherein the lower horizontal element (36) is spaced from the base (20, 40).

9. The edge protection system according to any preceding claim wherein at least one intermediate horizontal element (38) is provided between the upper (34) and lower (36) horizontal elements.

10. The edge protection system according to any of the claims 8,9, wherein the uprights (32) are of substantially similar height and a lower end of each upright constitutes a plug or socket (35) for engagement in a complementary socket or plug (12) of two respective fixing means.

11. The edge protection system according to claim 9 wherein the post (62) is configured for attachment between at least two of the upper (34), lower (36) or intermediate (38) horizontal elements of the barrier (30).

12. The edge protection system according to any preceding claim wherein the post (62) has a length which

is slightly greater than the distance between the upper (34) and lower (36) horizontal elements of the barrier (30).

13. The edge protection system according to any one of claims 11 to 12 wherein the post (62) is attachable to the horizontal elements (34, 36, 38) of a barrier via upper (66) and lower (64) hooks.

Patentansprüche

1. Kantenschutzsystem (10) für eine Basis (20, 40), wobei das Kantenschutzsystem umfasst: ein Fixiermittel (12, 14), das integral mit der Basis (20, 40) ausgebildet ist oder daran gesichert werden kann; und eine Barriere (30), die mindestens zwei horizontal voneinander beabstandete Stützen (32) mit einem sich dazwischen erstreckenden oberen und einem unteren Horizontalelement (34, 36) umfasst; mindestens eine angrenzende, zusätzliche Barriere (50) und jeweilige Fixiermittel (12, 14), wobei die Barriere (30) für einen lösbaren Eingriff mit den Fixiermitteln (12, 14) konfiguriert ist, um die Barriere (30) an der Basis festzuhalten, wenn die Basis zu einer Arbeitsposition angehoben wird, wobei Kopplungsmittel (54, 64, 66) vorgesehen sind, um die Barrieren (30, 50) zu verkoppeln, und wobei ein Verbindungsstück (60) vorgesehen ist, um die zusätzliche Barriere (50) mit der Barriere (30) mit einem dazwischen befindlichen Überlappungsgrad verkoppeln zu können, wobei das Verbindungsstück (60) an einem beliebigen Punkt entlang der Länge der Barriere an der Barriere (30) befestigt werden kann, und wobei das Verbindungsstück so konfiguriert ist, dass die zusätzliche Barriere an der Barriere gesichert werden kann, wobei das Verbindungsstück (60) einen Pfosten (62) mit einer ersten Reihe von Kopplungselementen (64, 66) umfasst, um den Pfosten an der Barriere zu befestigen, **dadurch gekennzeichnet, dass** eine zweite Reihe von Kopplungsmitteln (54), die konfiguriert sind, um die zusätzliche Barriere (50) am Pfosten (62) zu befestigen, an der zusätzlichen Barriere (50) vorgesehen ist.

2. Kantenschutzsystem nach Anspruch 1, wobei ein Balken, eine Bohle, eine Platte oder ein vorgefertigtes Bodenelement die Basis (20, 40) bildet.

3. Kantenschutzsystem nach Anspruch 1 oder Anspruch 2, wobei das Fixiermittel (12, 14) fest an der Basis (20, 40) gesichert ist.

4. Kantenschutzsystem nach einem der vorstehend aufgeführten Ansprüche, wobei das Fixiermittel (12, 14) eine Buchse (12) oder einen Stopfen umfasst, die bzw. der für einen Eingriff mit einem Teil der Barriere konfiguriert ist, das einen ergänzenden Stopfen oder eine ergänzende Buchse (35) bildet.

5. Kantenschutzsystem nach einem der vorstehend aufgeführten Ansprüche, wobei die Buchse (12, 35) die Form eines zylindrischen Rohrs und der Stopfen (12, 35) die Form eines zylindrischen Stabes aufweist.

6. Kantenschutzsystem nach einem der vorstehend aufgeführten Ansprüche, wobei ein Zwischenelement (14) zwischen dem Fixiermittel (12) und der Barriere vorgesehen ist.

7. Kantenschutzsystem nach einem der vorstehend aufgeführten Ansprüche, wobei die Barriere (30) mindestens eine Öffnung umfasst, die konfiguriert ist, um dadurch einen Zugang zu ermöglichen.

8. Kantenschutzsystem nach einem der vorstehend aufgeführten Ansprüche, wobei das untere Horizontalelement (36) von der Basis (20, 40) beabstandet ist.

9. Kantenschutzsystem nach einem der vorstehend aufgeführten Ansprüche, wobei mindestens ein zwischen den oberen (34) und unteren (36) Horizontalelementen befindliches Horizontalelement (38) vorgesehen ist.

10. Kantenschutzsystem nach einem der Ansprüche 8 oder 9, wobei die Stützen (32) im Wesentlichen eine ähnliche Höhe aufweisen und ein unteres Ende einer jeden Stütze einen Stopfen oder eine Buchse (35) bildet, um in eine ergänzende Buchse oder einen ergänzenden Stopfen (12) von zwei jeweiligen Fixiermitteln einzugreifen.

11. Kantenschutzsystem nach Anspruch 9, wobei der Pfosten (62) konfiguriert ist, um zwischen mindestens zwei der oberen (34), der unteren (36) oder der dazwischen befindlichen (38) Horizontalelemente der Barriere (30) befestigt zu werden.

12. Kantenschutzsystem nach einem der vorstehend aufgeführten Ansprüche, wobei der Pfosten (62) eine Länge hat, die geringfügig größer als die Distanz zwischen den oberen (34) und den unteren (36) Horizontalelementen der Barriere (30) ist.

13. Kantenschutzsystem nach einem der Ansprüche 11 bis 12, wobei der Pfosten (62) an den Horizontalelementen (34, 36, 38) einer Barriere über obere (66) und untere (64) Hakten befestigt werden kann.

Revendications

1. Système de protection de bord (10) pour une base

(20, 40), le système de protection de bord comprenant:

des moyens de fixation (12, 14) pouvant être attachés ou intégrés à ladite base (20, 40), et une barrière (30) comprenant au moins deux montants espacés horizontalement l'un de l'autre (32) avec un élément horizontal supérieur et inférieur (34, 36) qui s'étend entre ceux-ci,
au moins une barrière supplémentaire adjacente (50) et des moyens de fixation respectifs (12, 14),
ladite barrière (30) est configurée de manière à s'engager de façon détachable avec les moyens de fixation (12, 14) de manière à retenir la barrière (30) sur ladite base, lorsque ladite base est élevée dans une position de travail;
dans lequel des moyens de couplage (54, 64, 66) sont prévus pour coupler les barrières (30, 50) l'une à l'autre; et
dans lequel un coupleur (60) est prévu dans le but de permettre que la barrière supplémentaire (50) soit couplée à la barrière (30) avec un degré de chevauchement entre celles-ci;
le coupleur (60) peut être attaché à la barrière (30) à n'importe quel point le long de la longueur de la barrière, et dans lequel le coupleur est configuré de manière à attacher la barrière supplémentaire à ladite barrière;
le coupleur (60) comprend un piquet (62) qui comporte une première série de moyens de couplage (64, 66) configurés de manière à attacher le piquet à la barrière;
caractérisé en ce qu'une seconde série de moyens de couplage (54), configurés de manière à attacher la barrière supplémentaire (50) au piquet (62), est prévue sur la barrière supplémentaire (50).

2. Système de protection de bord selon la revendication 1, dans lequel une poutre, une dalle, un panneau ou un élément de plancher préfabriqué constitue la base (20, 40).

3. Système de protection de bord selon la revendication 1 ou la revendication 2, dans lequel les moyens de fixation (12, 14) sont attachés fixement à la base (20, 40).

4. Système de protection de bord selon l'une quelconque des revendications précédentes, dans lequel les moyens de fixation (12, 14) comprennent une douille (12) ou une fiche configurée de manière à s'engager avec une partie de la barrière qui constitue une fiche ou une douille complémentaire (35).

5. Système de protection de bord selon l'une quelconque des revendications précédentes, dans lequel la douille (12, 35) se présente sous la forme d'un tube cylindrique et la fiche (12, 35) se présente sous la forme d'une tige cylindrique.

6. Système de protection de bord selon l'une quelconque des revendications précédentes dans lequel un élément intermédiaire (14) est prévu entre les moyens de fixation (12) et la barrière.

7. Système de protection de bord selon l'une quelconque des revendications précédentes, dans lequel la barrière (30) comporte au moins une ouverture configurée de manière à permettre un accès à travers celle-ci.

8. Système de protection de bord selon l'une quelconque des revendications précédentes, dans lequel l'élément horizontal inférieur (36) est espacé de la base (20, 40).

9. Système de protection de bord selon l'une quelconque des revendications précédentes, dans lequel au moins un élément horizontal intermédiaire (38) est prévu entre les éléments horizontaux supérieur (34) et inférieur (36).

10. Système de protection de bord selon l'une quelconque des revendications 8 ou 9, dans lequel les montants (32) présentent une hauteur sensiblement similaire et une extrémité inférieure de chaque montant constitue une fiche ou une douille (35) à engager dans une douille ou une fiche complémentaire (12) de deux moyens de fixation respectifs.

11. Système de protection de bord selon la revendication 9, dans lequel le piquet (62) est configuré de manière à être fixé entre au moins deux des éléments horizontaux supérieur (34), inférieur (36) ou intermédiaire (38) de la barrière (30).

12. Système de protection de bord selon l'une quelconque des revendications précédentes, dans lequel le piquet (62) présente une longueur qui est légèrement plus grande que la distance entre les éléments horizontaux supérieur (34) et inférieur (36) de la barrière (30).

13. Système de protection de bord selon l'une quelconque des revendications 11 à 12, dans lequel le piquet (62) peut être attaché aux éléments horizontaux (34, 36, 38) d'une barrière par l'intermédiaire de crochets supérieur (66) et inférieur (64).

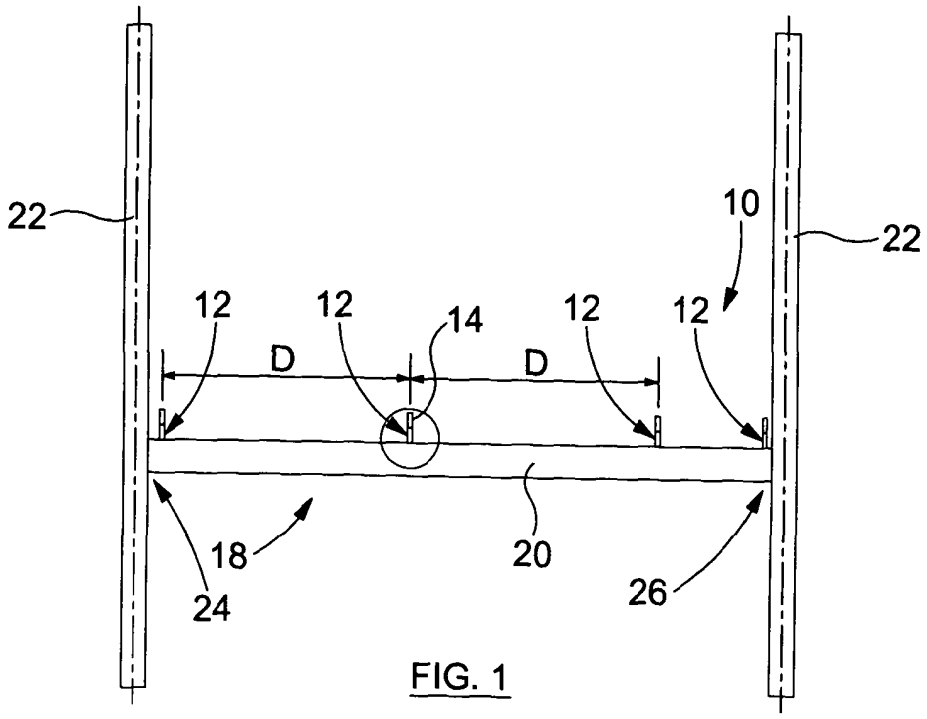


FIG. 1

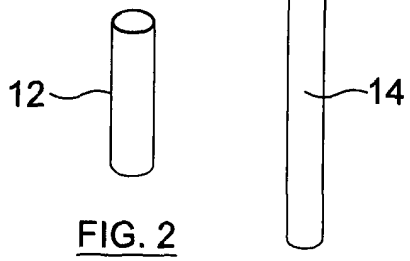


FIG. 2

FIG. 3

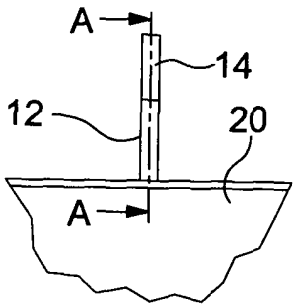


FIG. 4

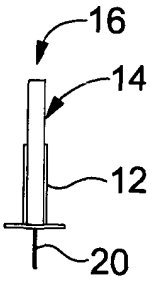


FIG. 5

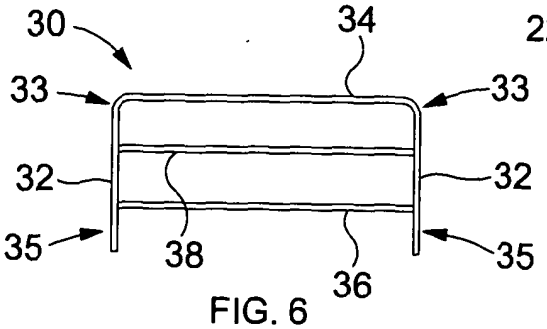


FIG. 6

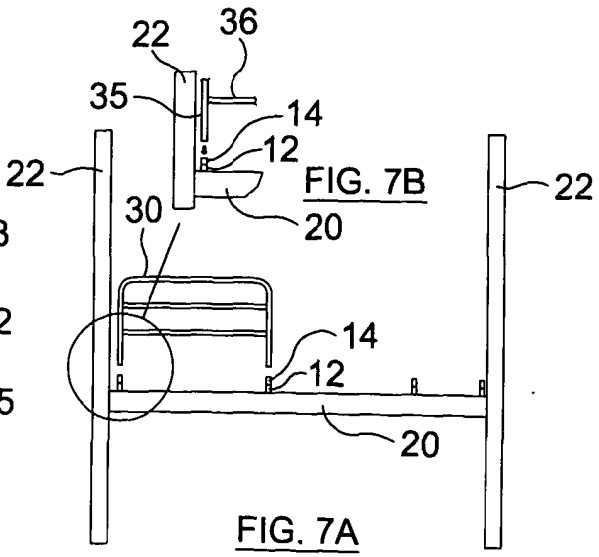


FIG. 7B

FIG. 7A

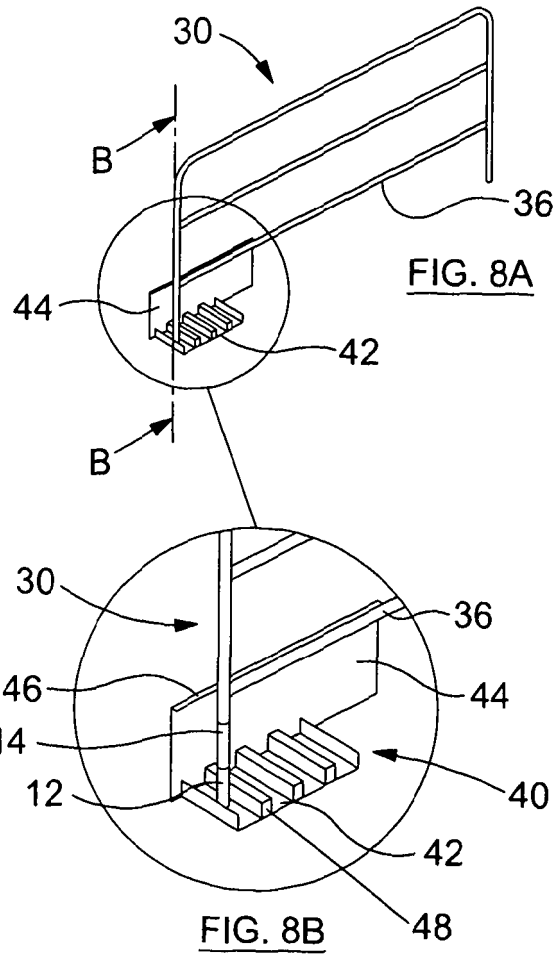


FIG. 8A

FIG. 8B

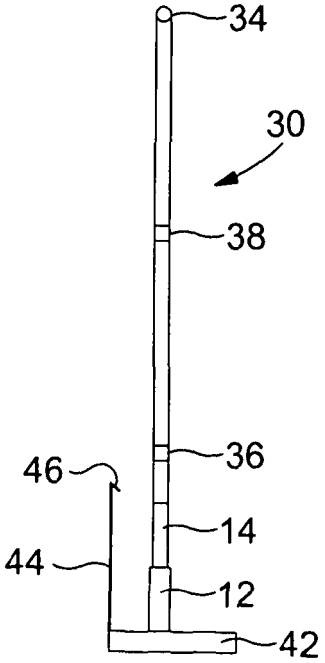


FIG. 9

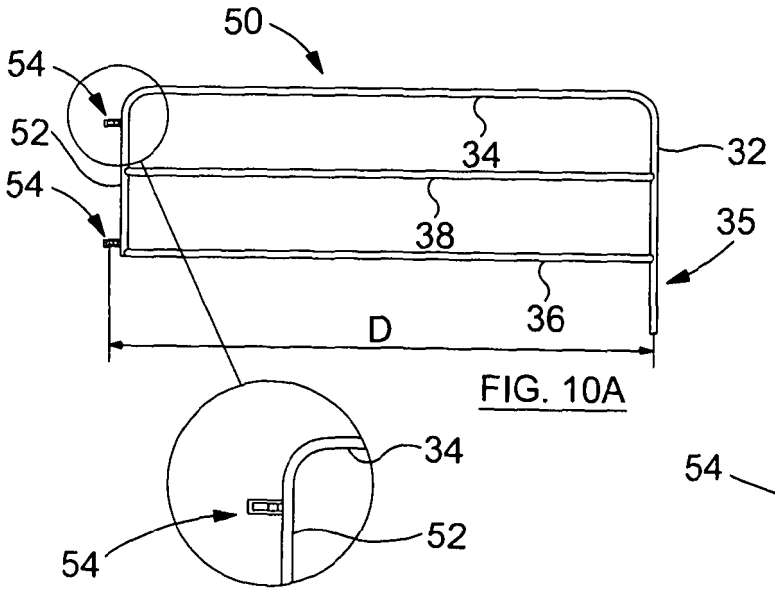


FIG. 10A

FIG. 10B

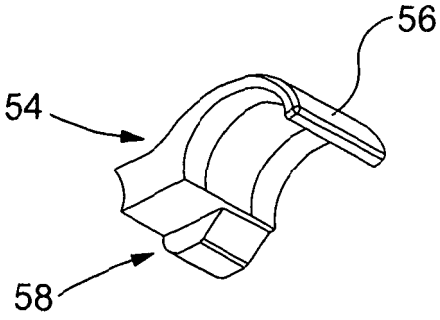


FIG. 11

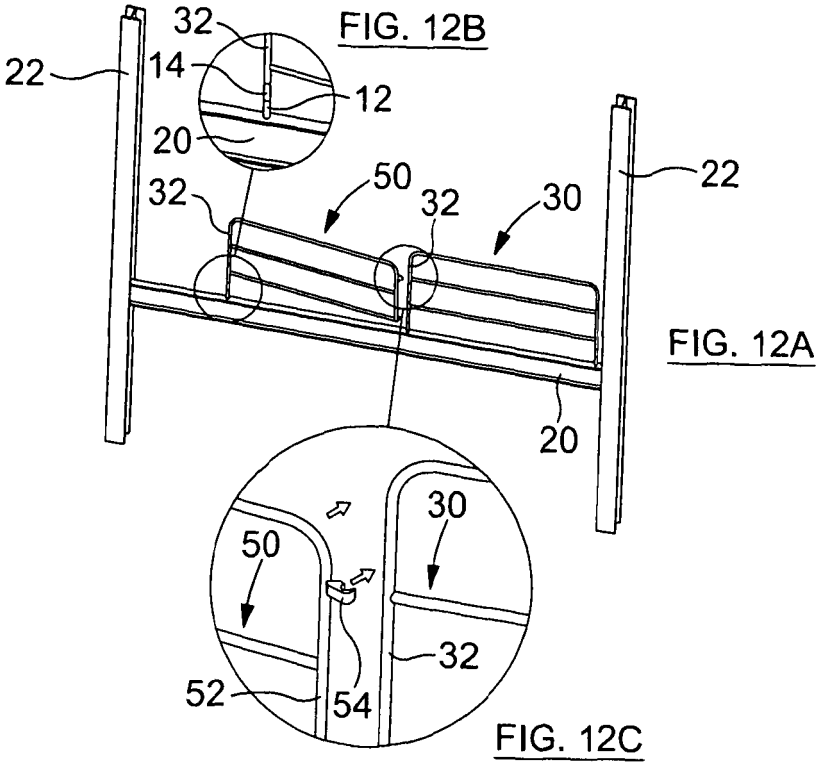


FIG. 12B

FIG. 12A

FIG. 12C

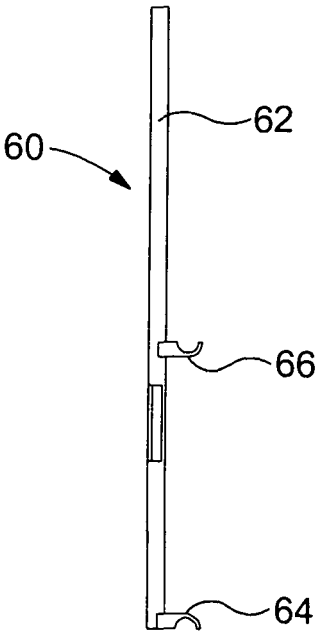


FIG. 13

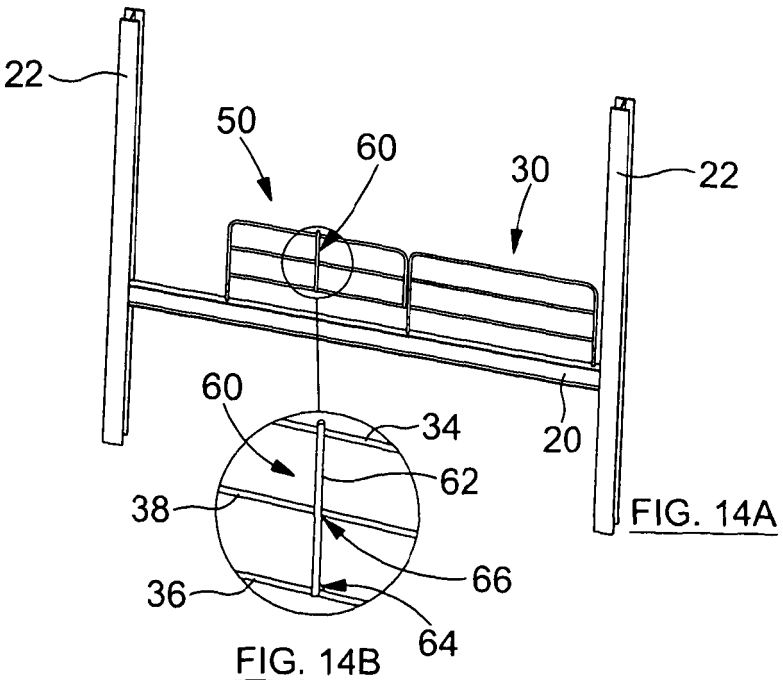


FIG. 14A

FIG. 14B

FIG. 15A

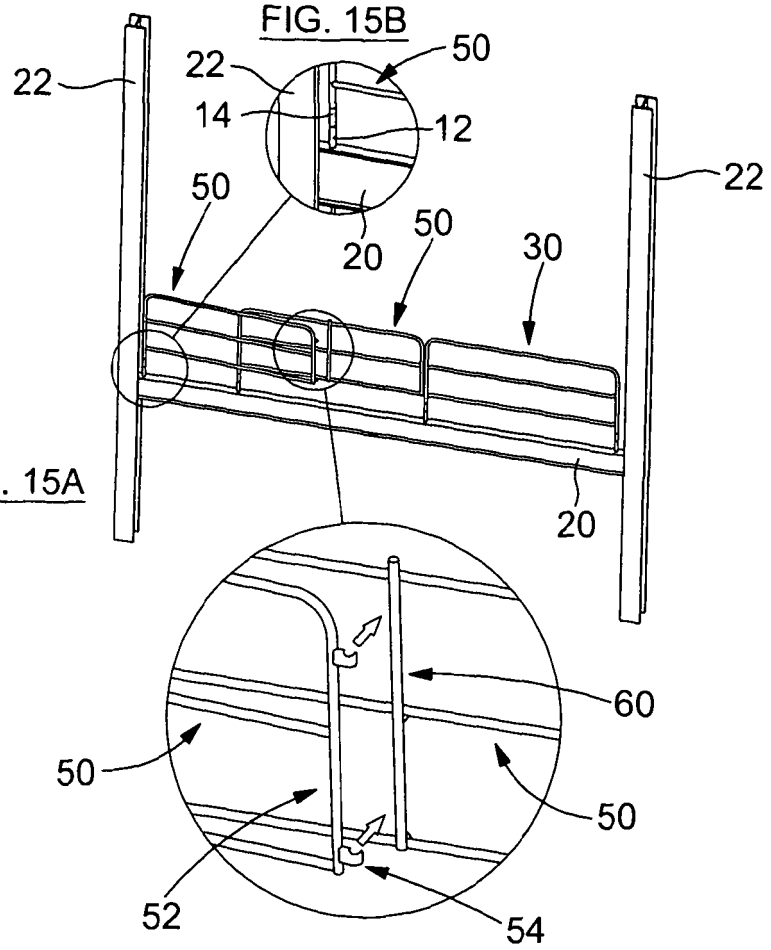


FIG. 15B

FIG. 15C

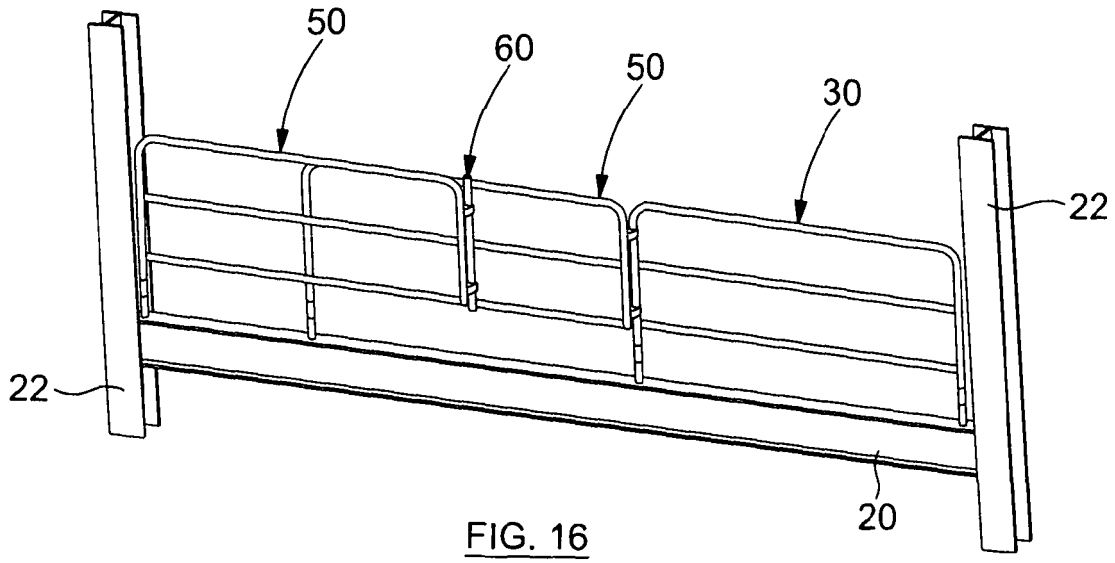


FIG. 16

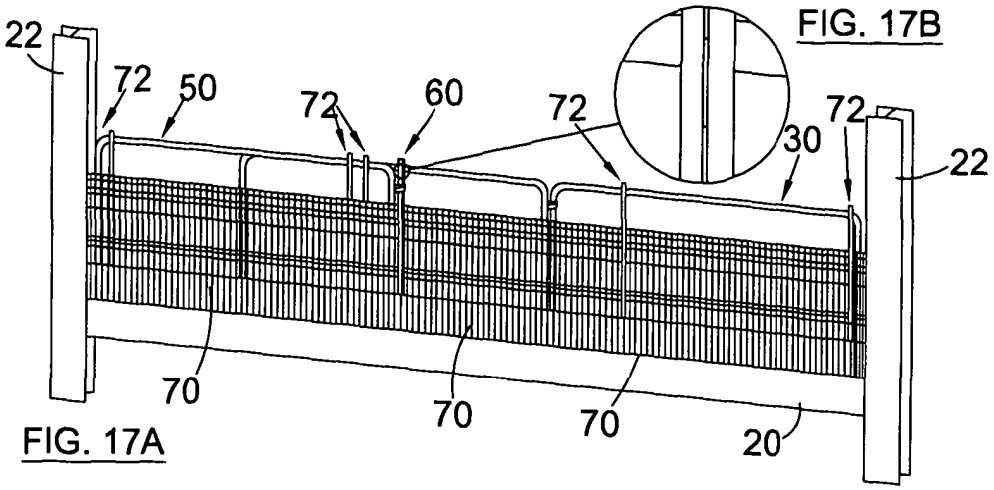


FIG. 17A

FIG. 17B

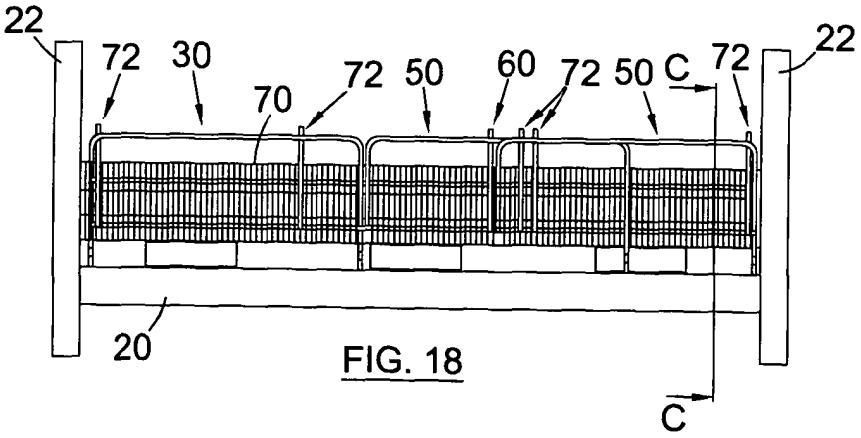


FIG. 18

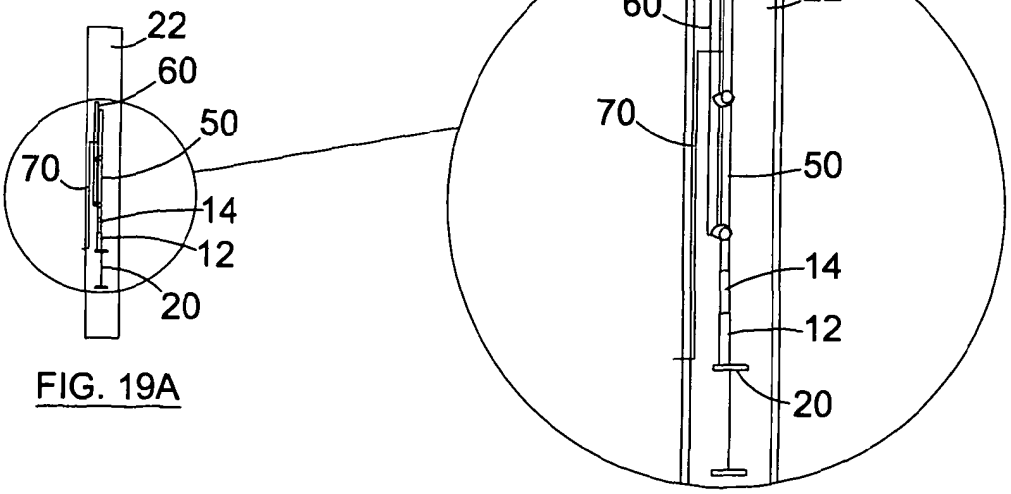


FIG. 19A

FIG. 19B

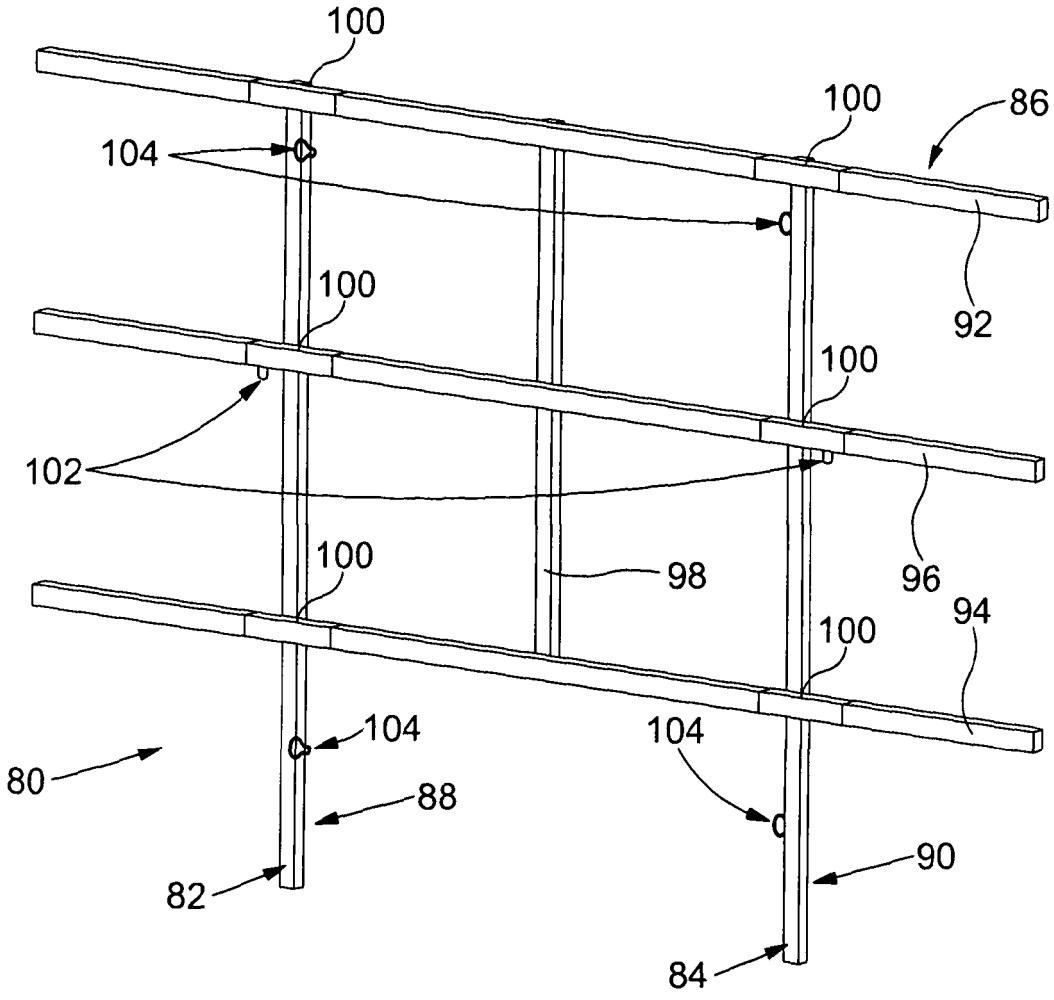

100
100
86
104
92
100
100
102
96
100
98
94
100
104
104
80
88
90
82
84

FIG. 20

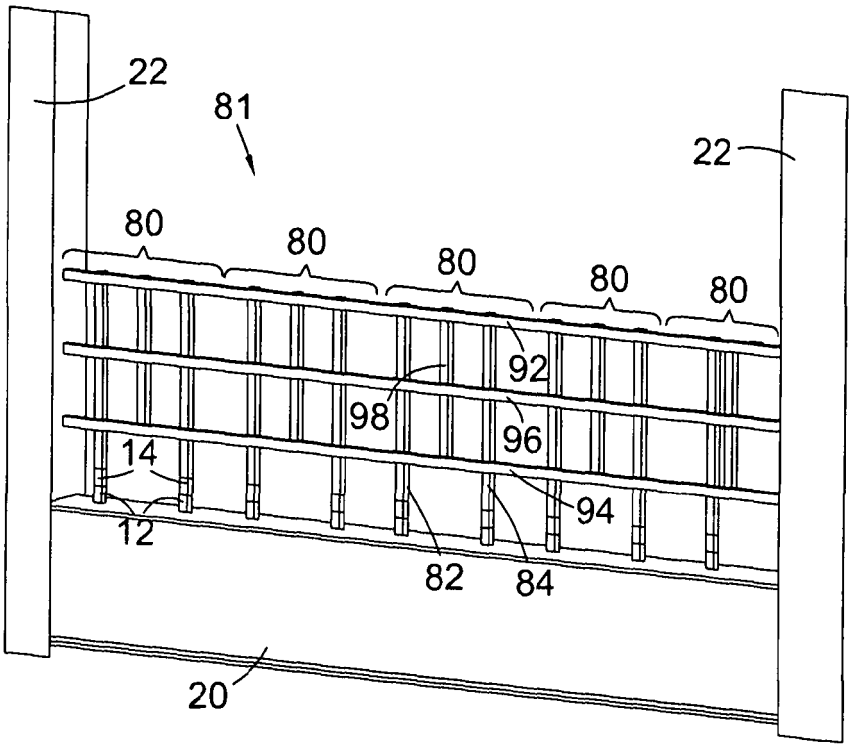

22
81
22
80
80
80
80
80
92
98
96
14
94
12
82
84
20

FIG. 21

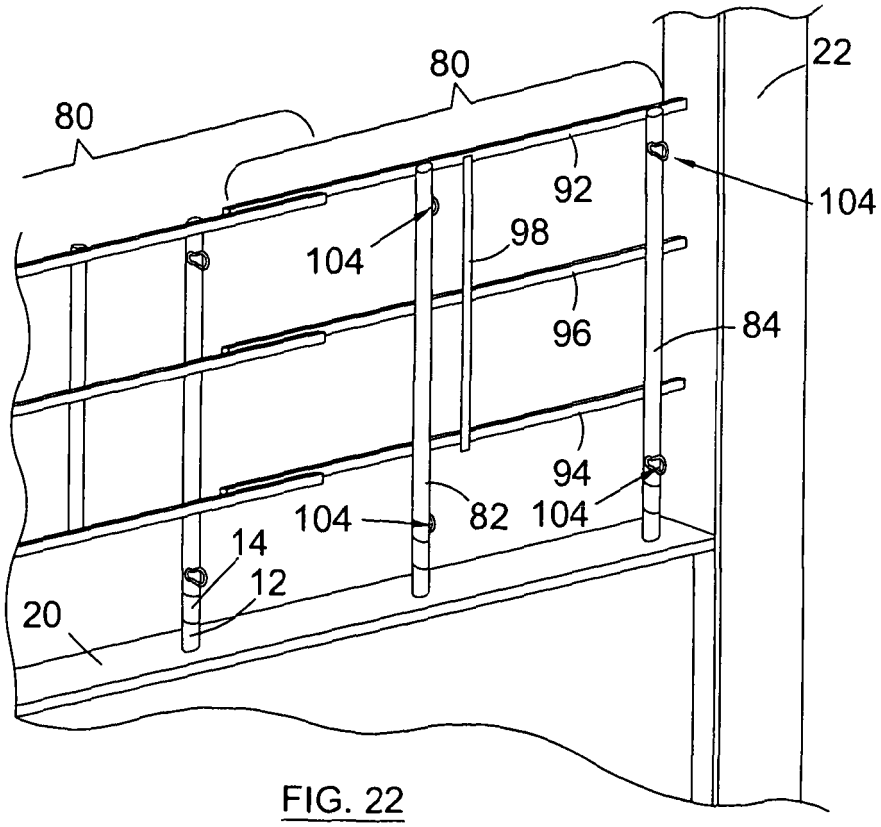

80
80
22
92
104
104
98
96
84
94
104
82
104
14
12
20

FIG. 22

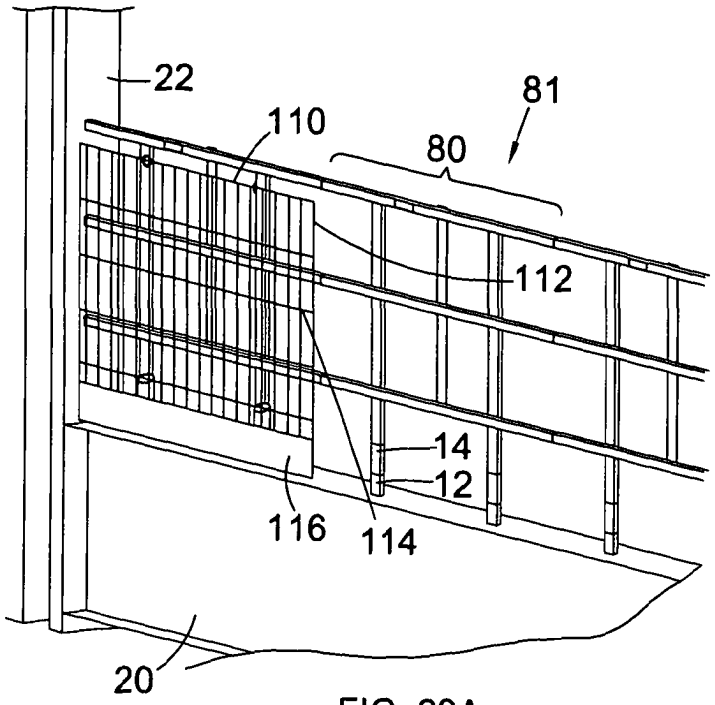


FIG. 23A

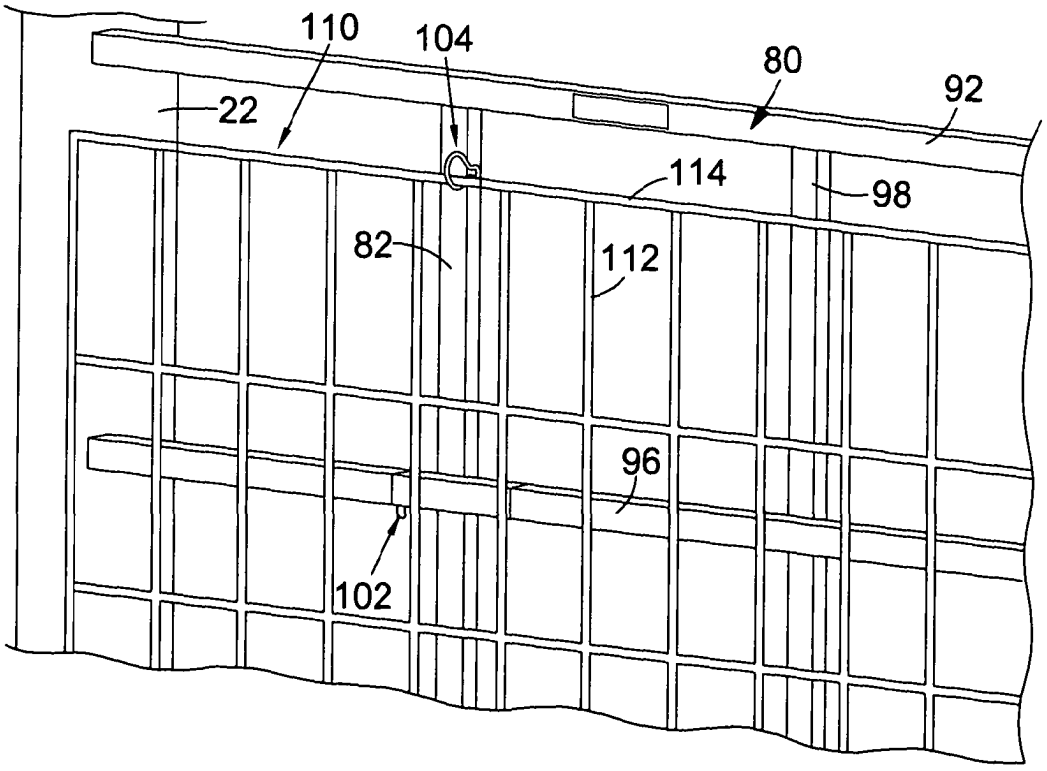


FIG. 23B

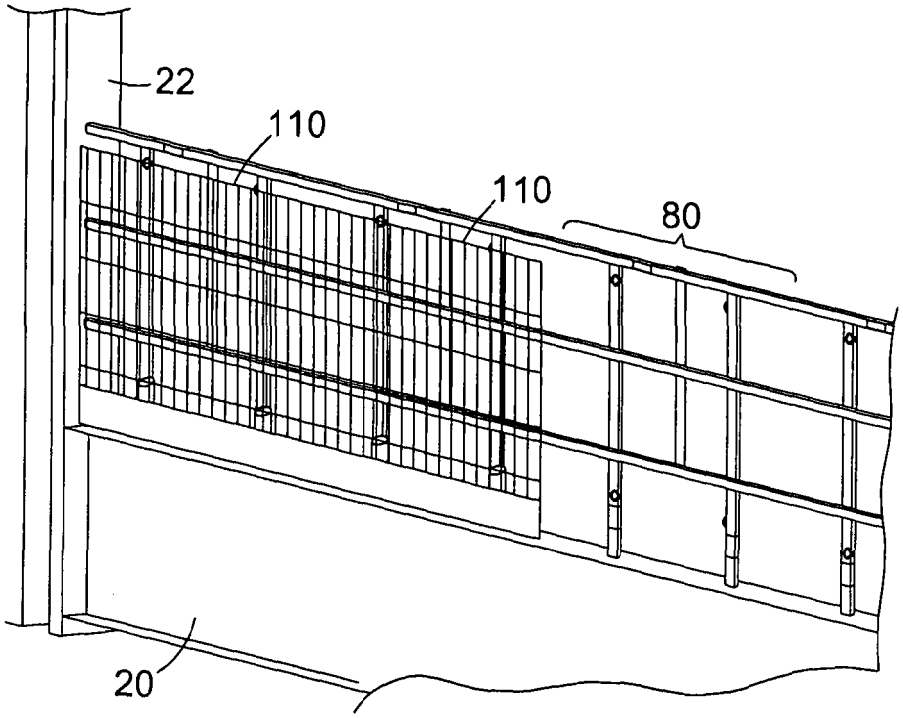


FIG. 24

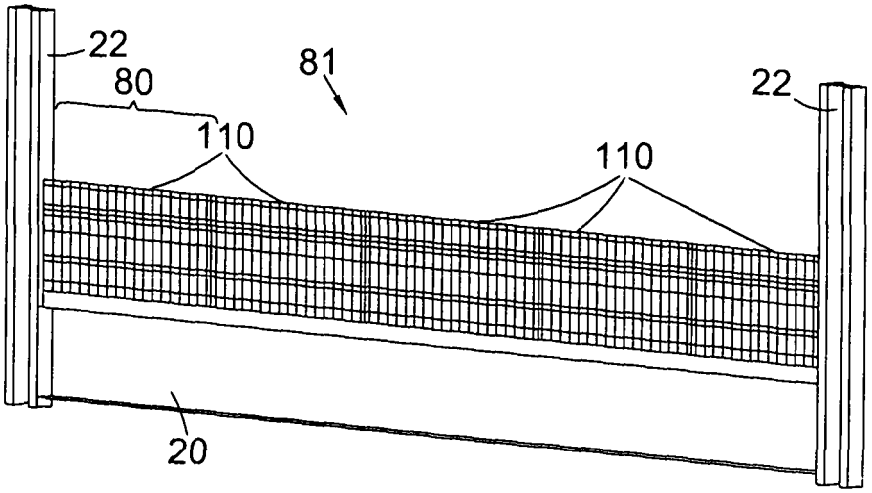


FIG. 25

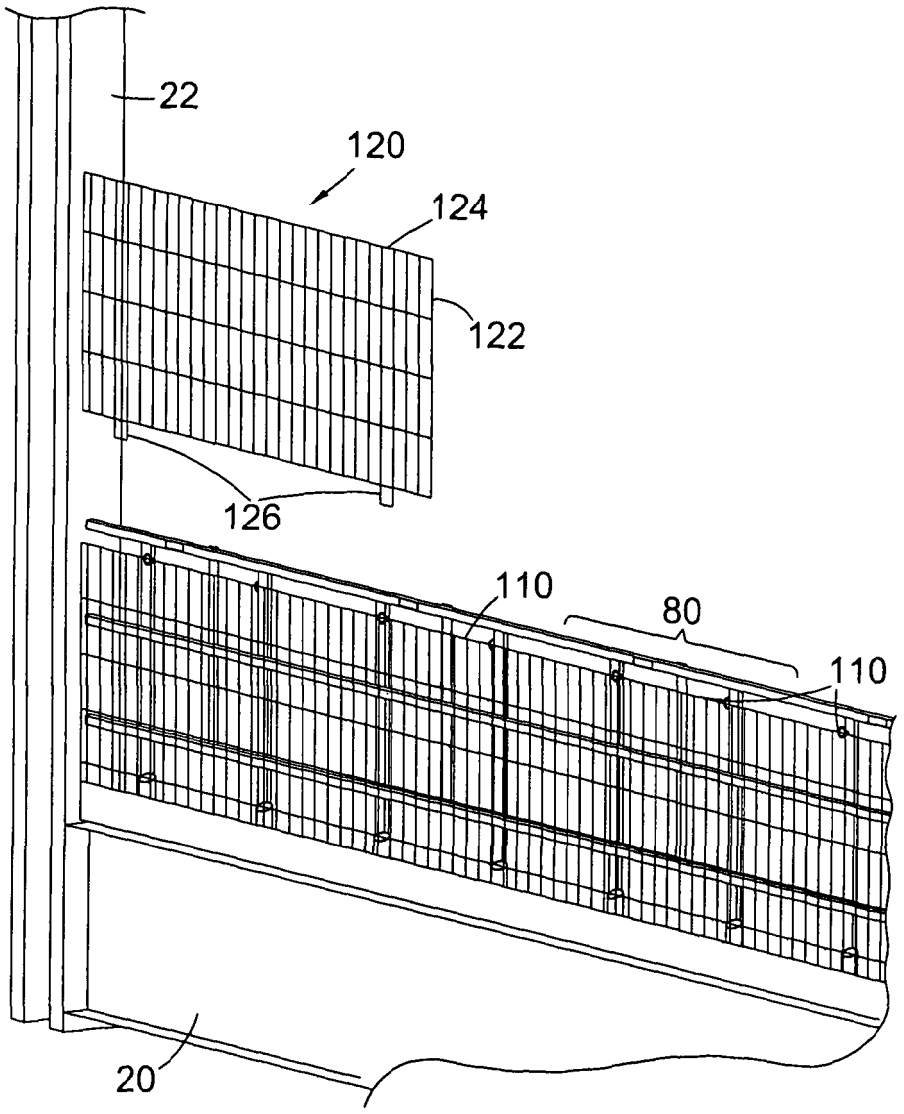


FIG. 26

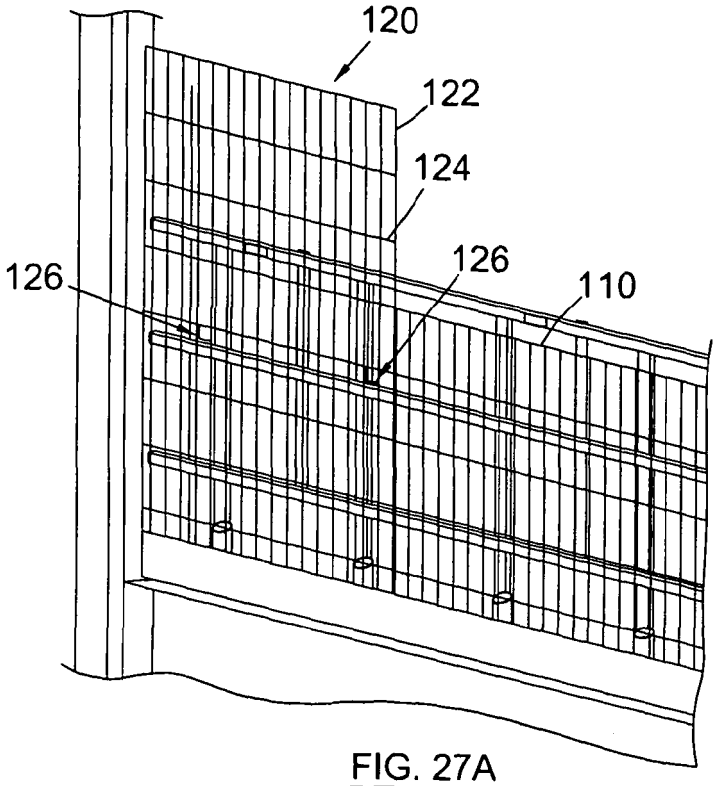


FIG. 27A

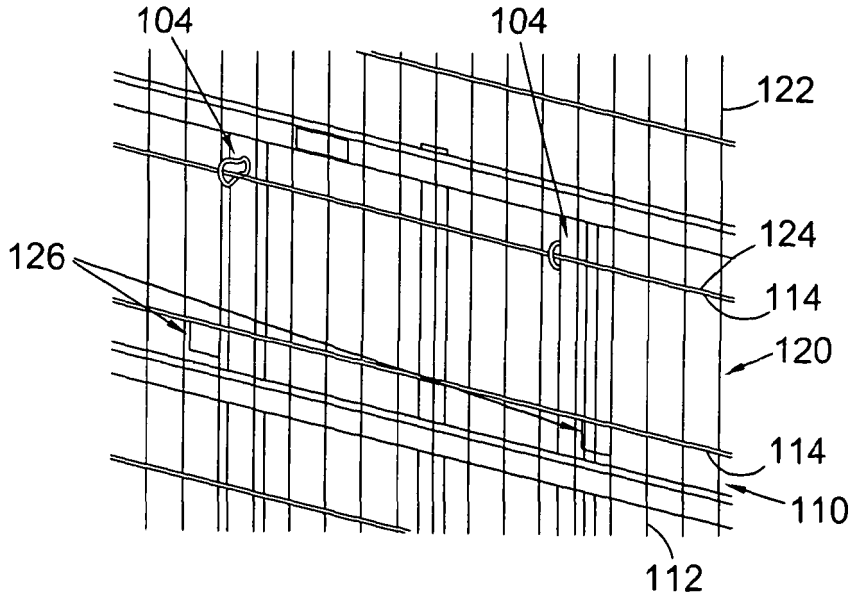


FIG. 27B

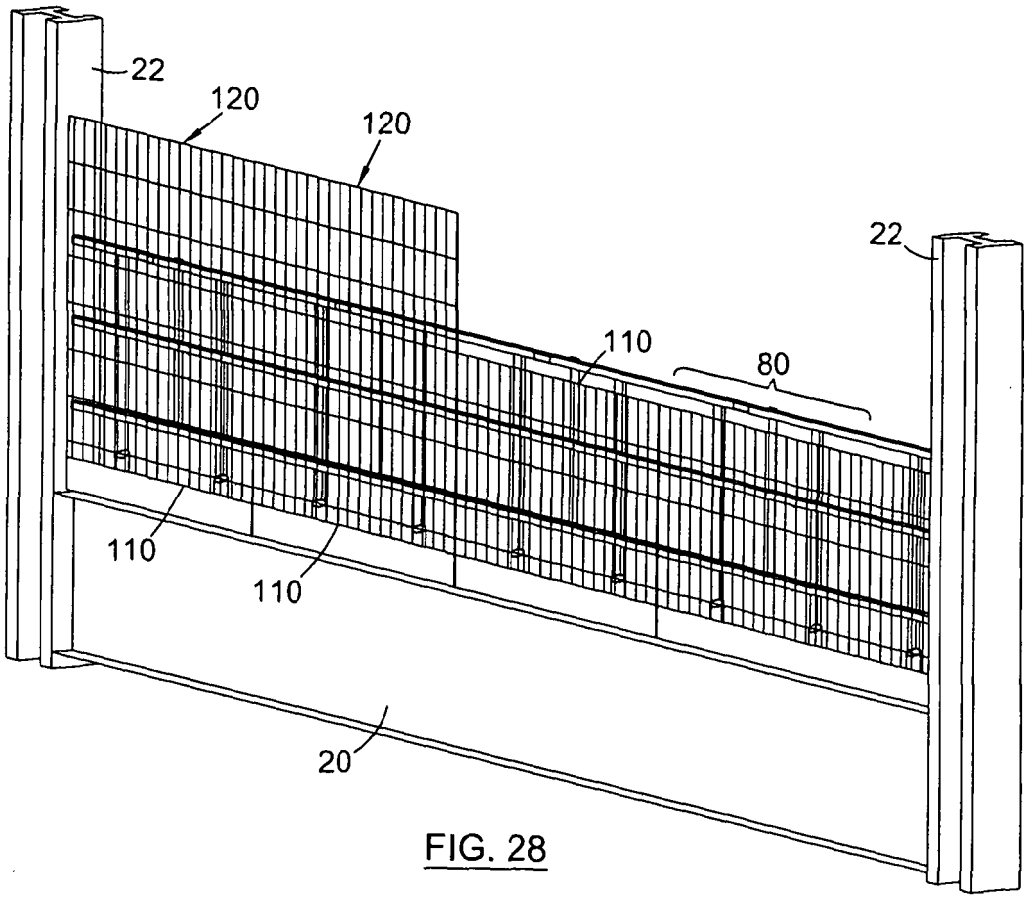

22
120
120
22
110
80
110
110
20

FIG. 28

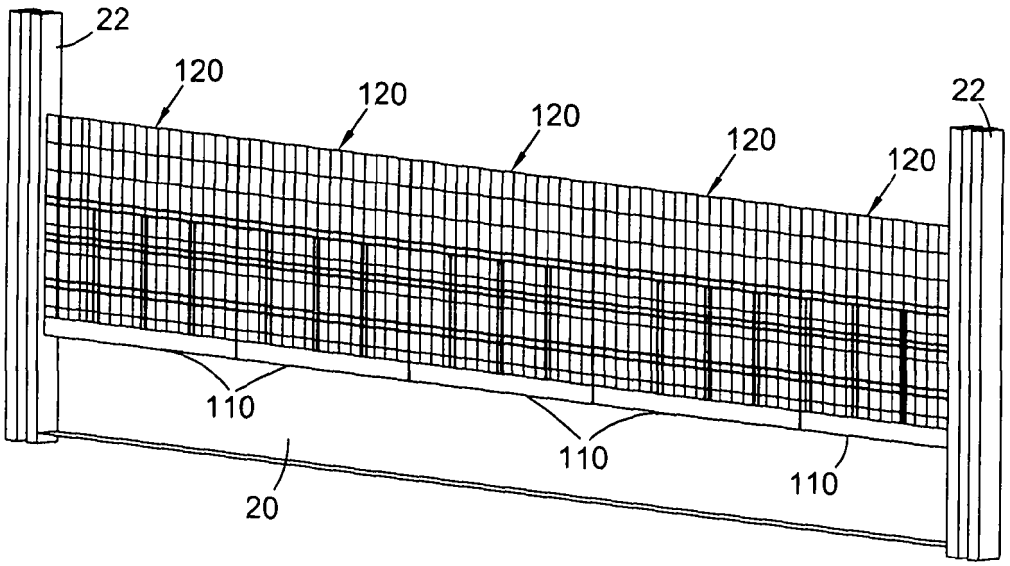

22
120
120
120
120
120
22
110
110
110
20

FIG. 29

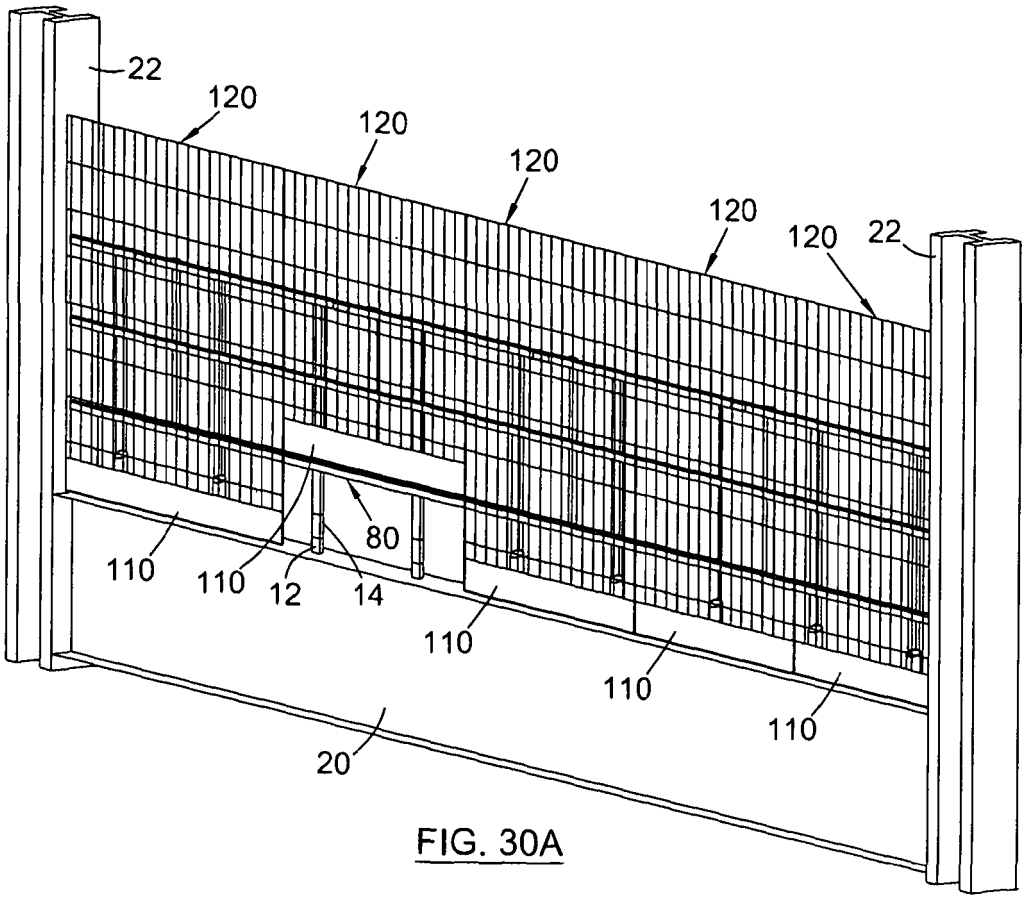


FIG. 30A

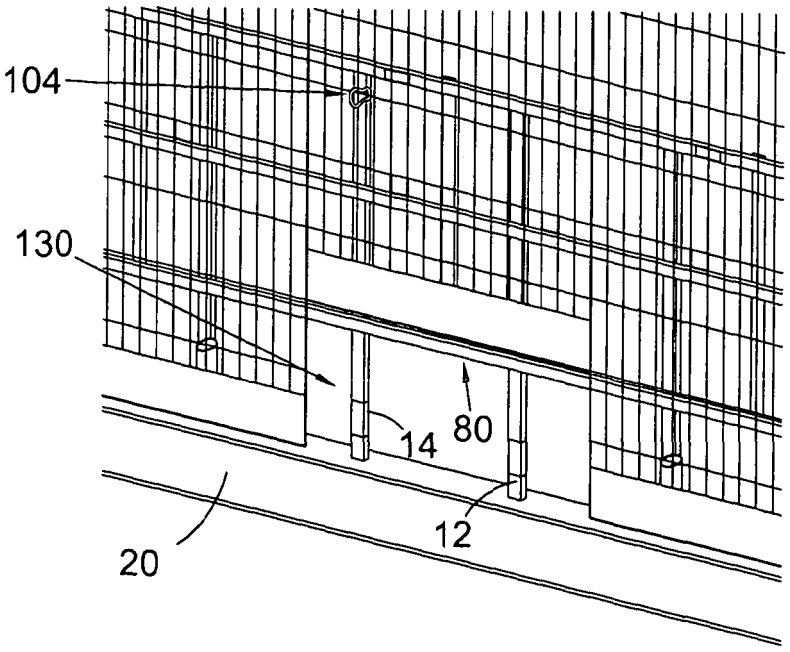


FIG. 30B

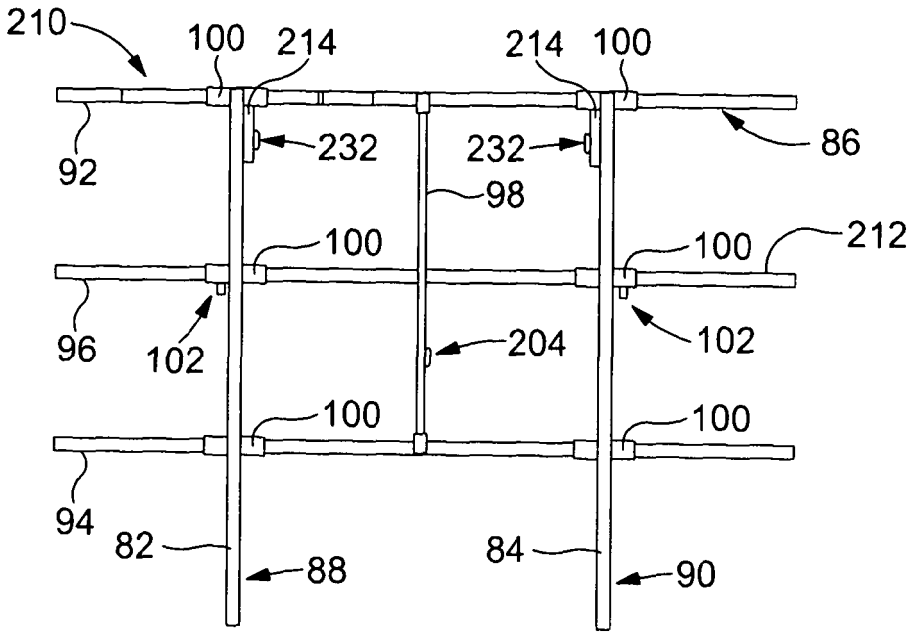


FIG. 31A

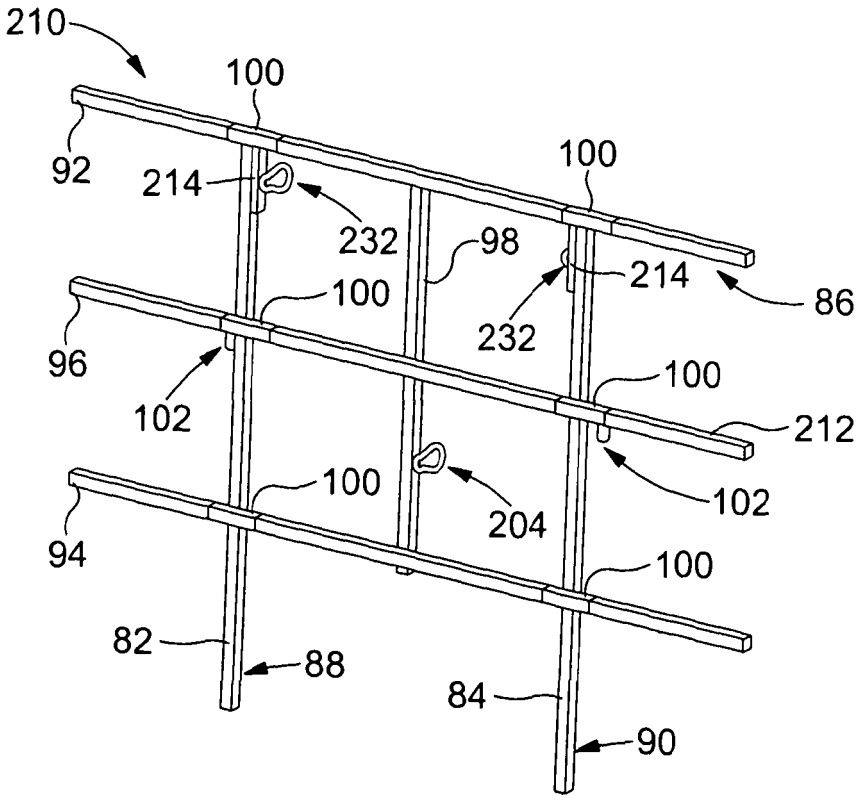


FIG. 31B

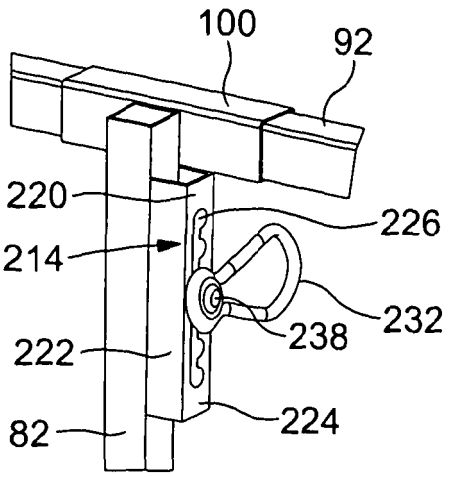


FIG. 32

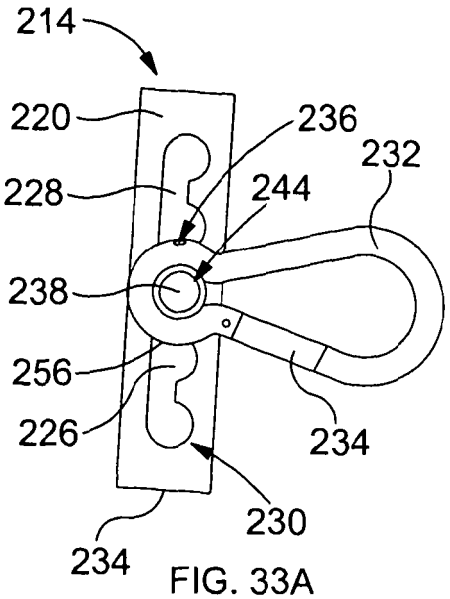


FIG. 33A

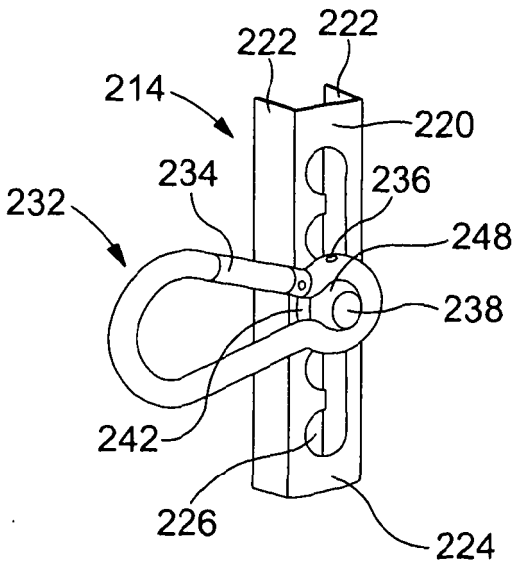


FIG. 33B

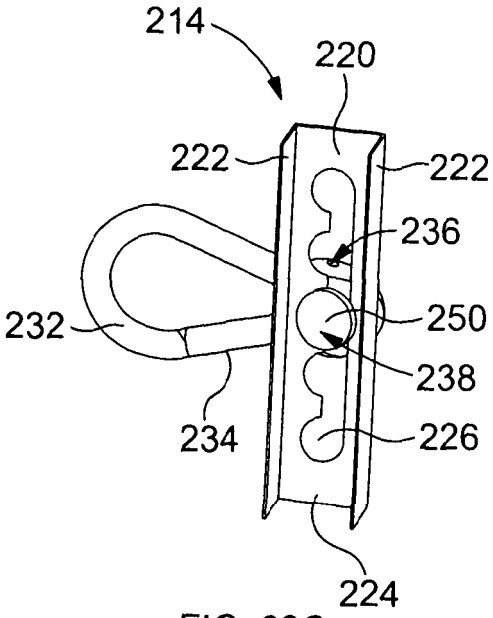


FIG. 33C

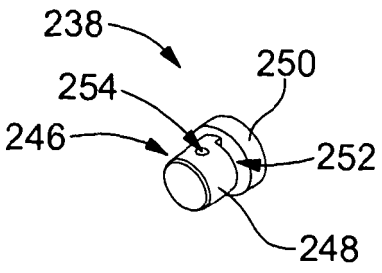


FIG. 34A

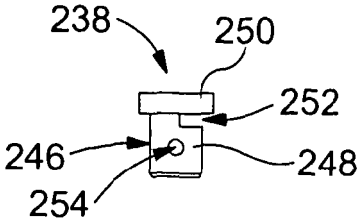


FIG. 34B

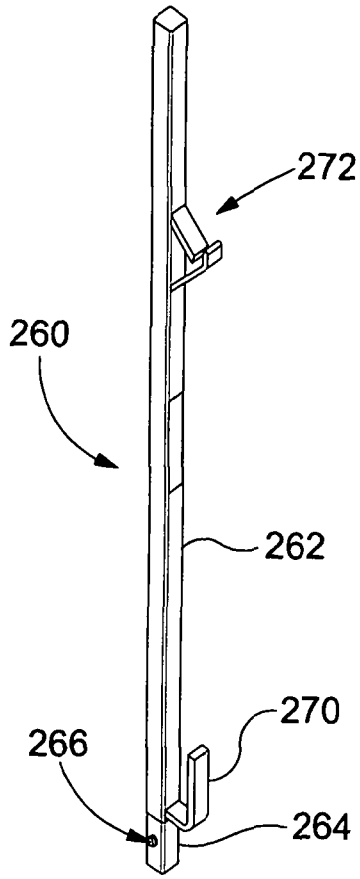


FIG. 35

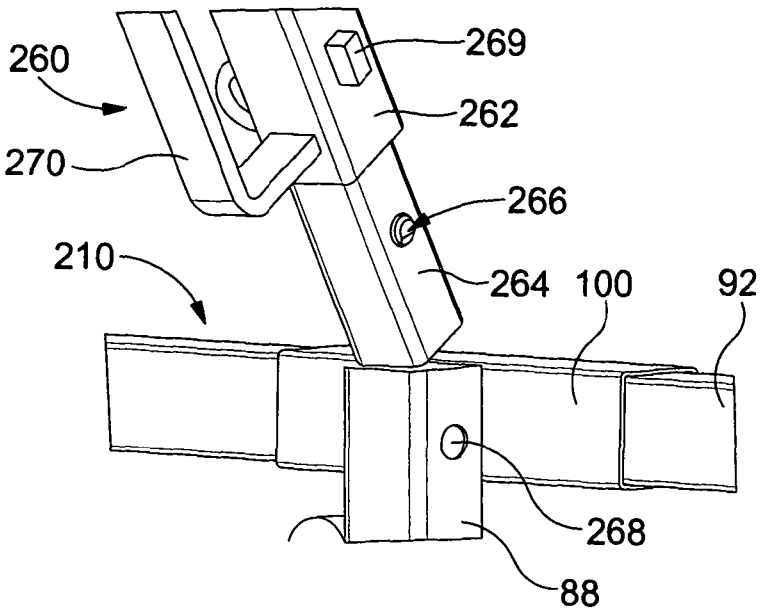


FIG. 36A

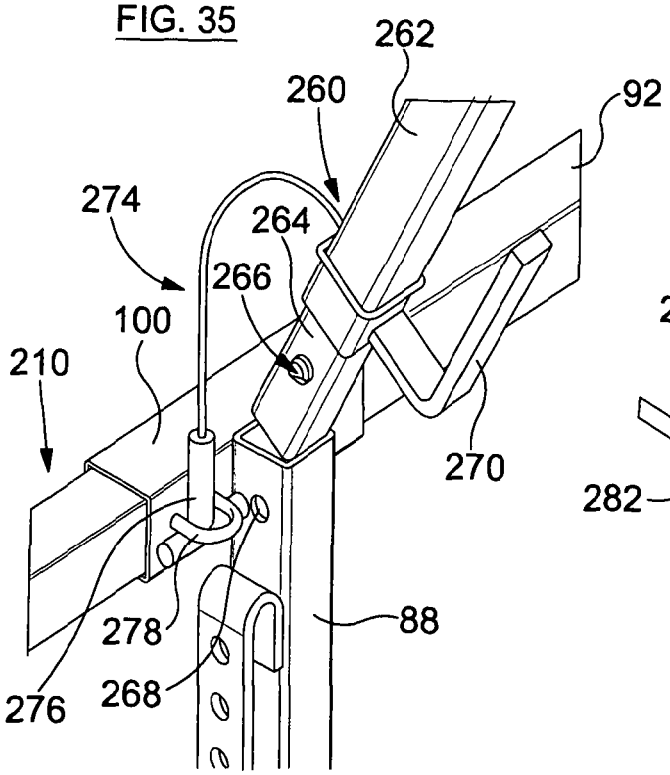


FIG. 36B

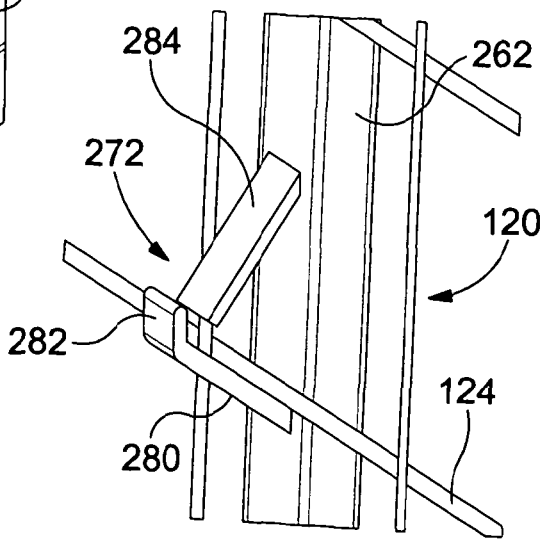


FIG. 37

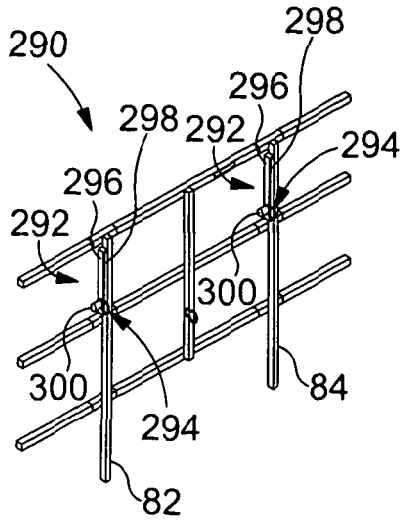


FIG. 38

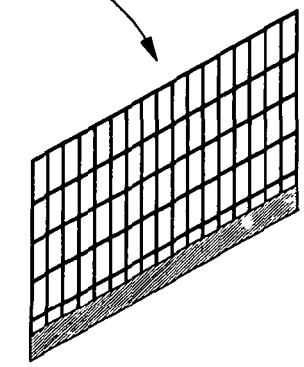


FIG. 39

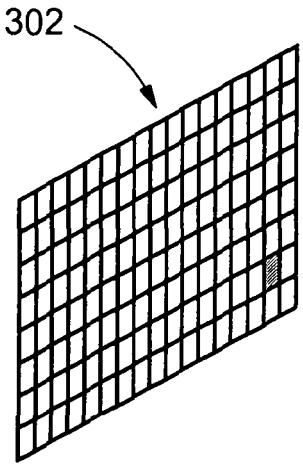


FIG. 40

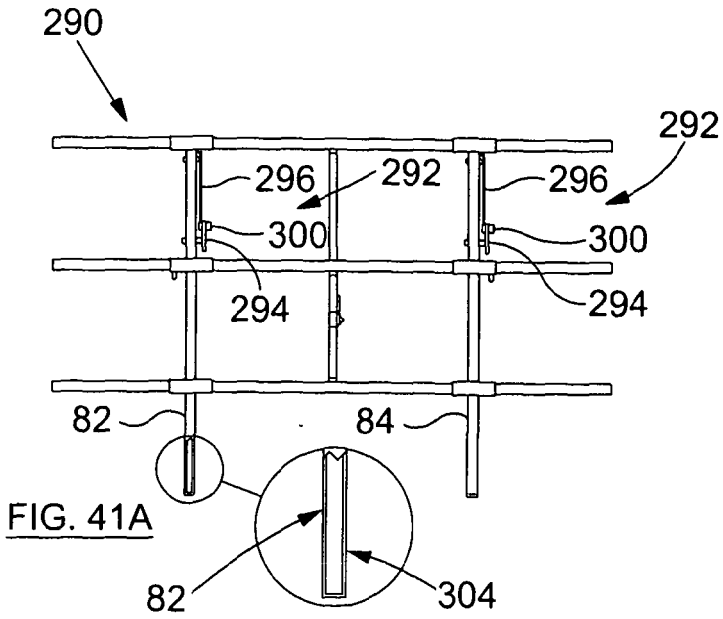


FIG. 41A

FIG. 41B

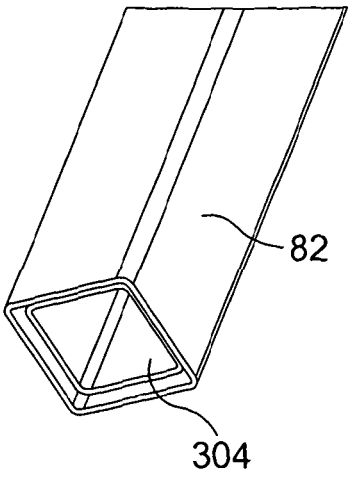


FIG. 41C

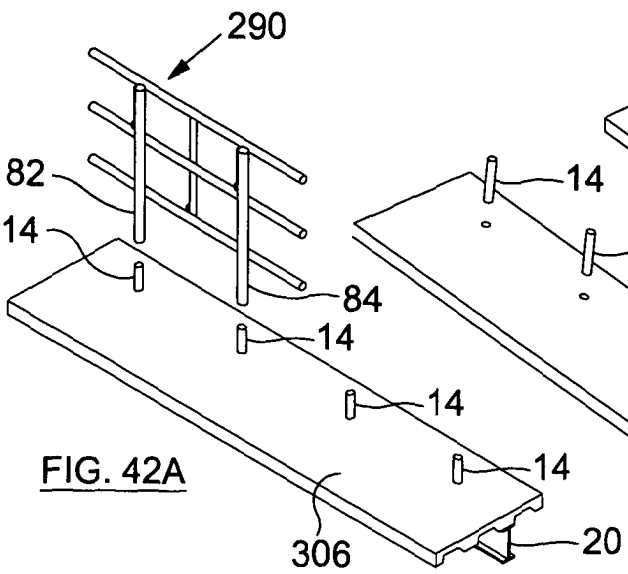


FIG. 42A

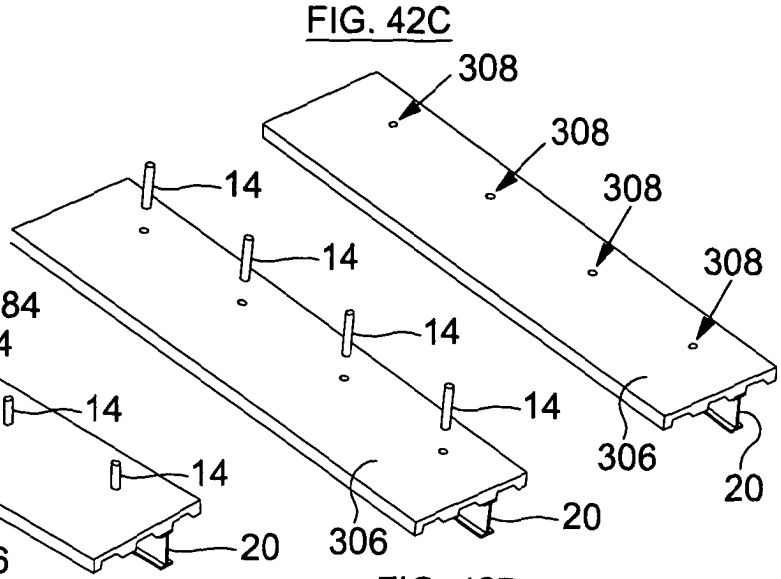


FIG. 42B

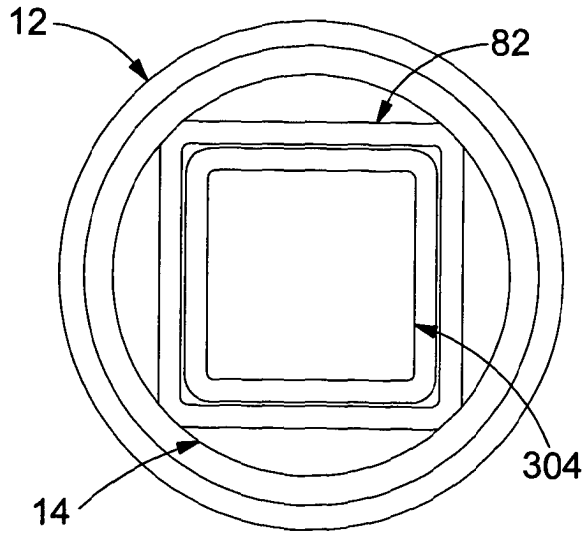


FIG. 43

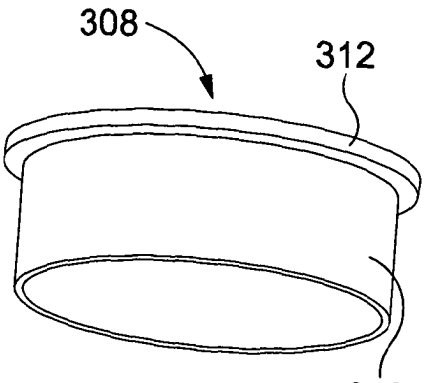


FIG. 44

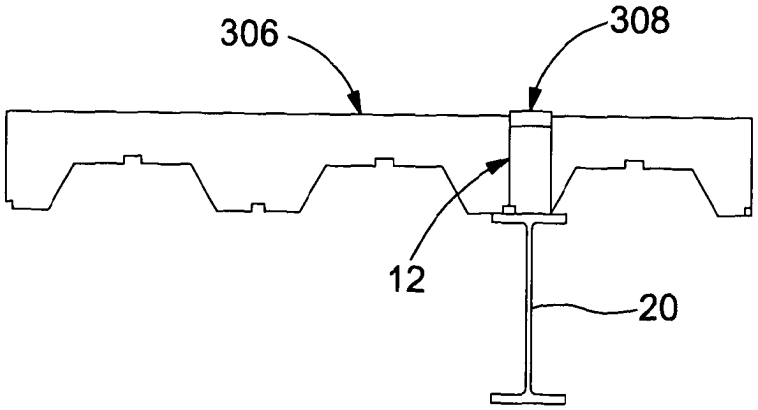


FIG. 45

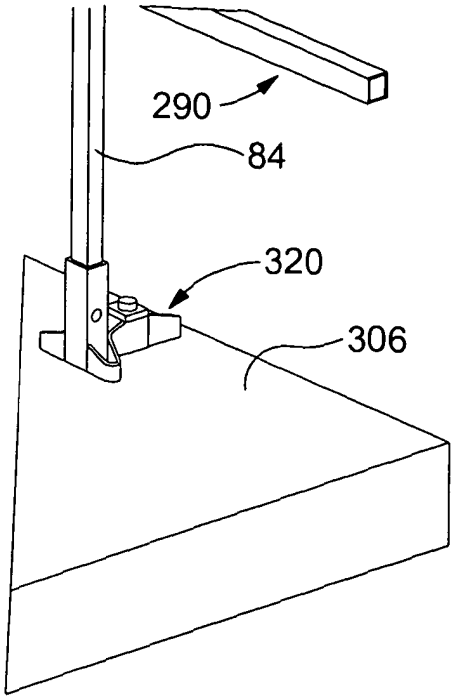


FIG. 46

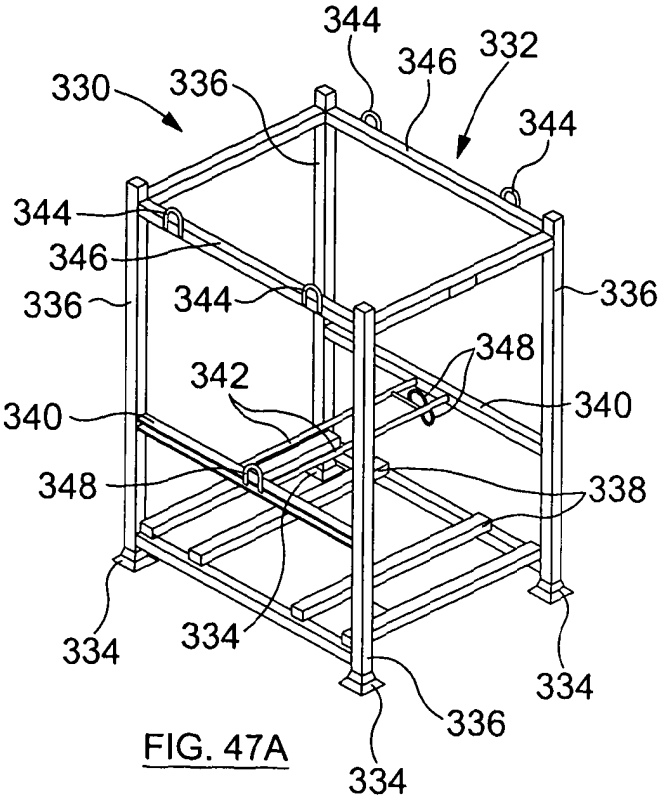


FIG. 47A

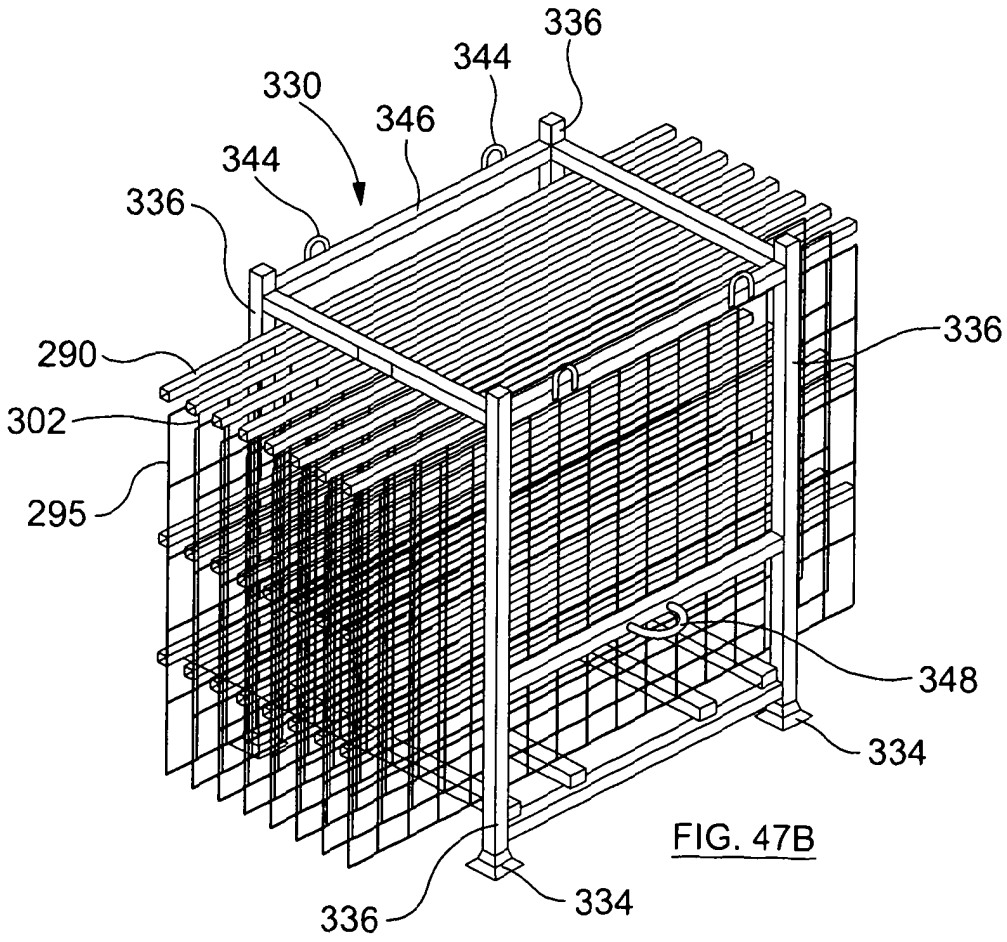


FIG. 47B

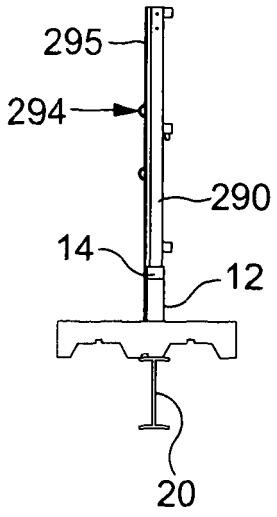


FIG. 48A

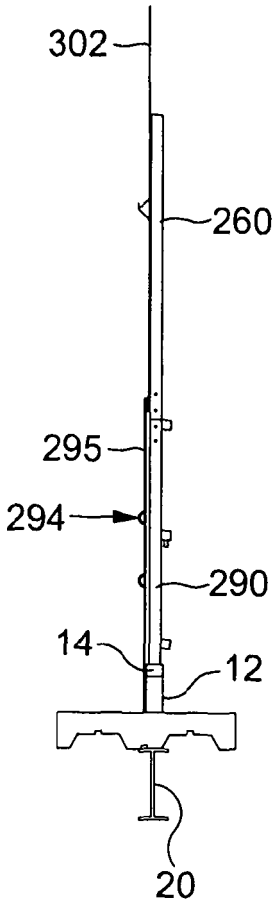


FIG. 48B

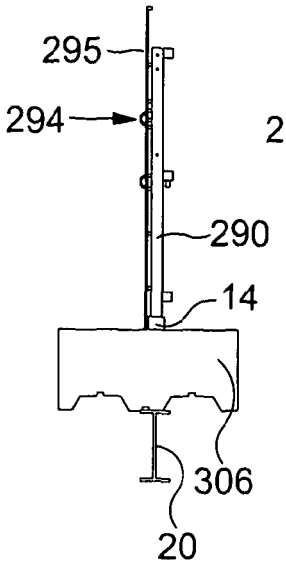


FIG. 49A

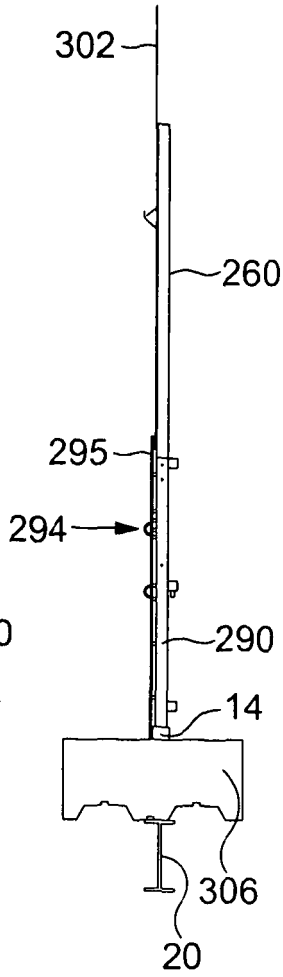


FIG. 49B

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 1878850 A2 **[0006]**
- EP 1820920 A **[0099]**
- EP 2065537 A **[0111]**