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(72) Inventors:  
• **Smith, Rodney Joh Hamer,**  
**c/o Futura Geosystems Ltd**  
**Albrighton, Wolverhampton WV7 3RA (GB)**  
• **Worrall, Paul Kimberley**  
**c/o Futura Geosystems Ltd.**  
**Albrighton, Wolverhampton WV7 3RA (GB)**

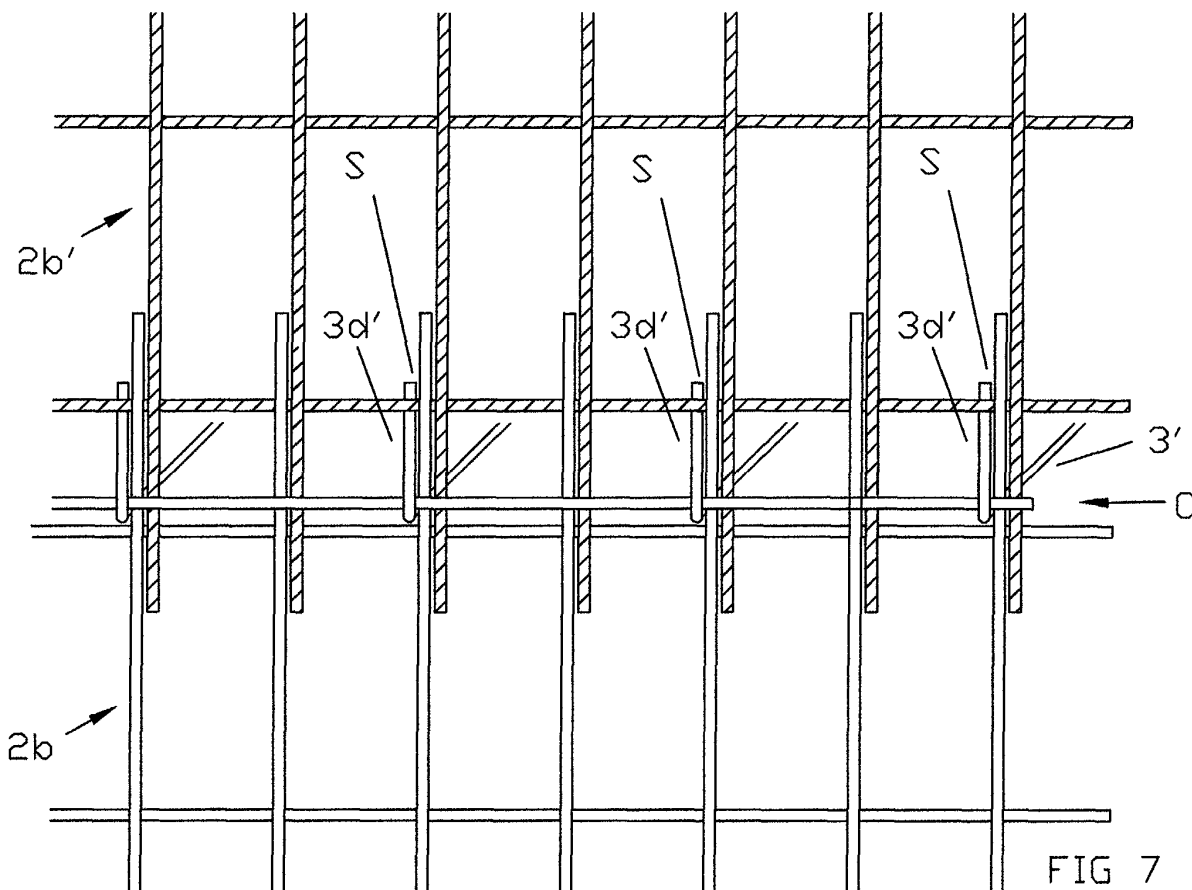
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(71) Applicant: **Futura Geosystems Ltd.**  
**Wolverhampton, WV7 3RA (GB)**

(54) **Retaining wall construction**

(57) FIGURES 7 and 8 show a retaining wall structure 1 having a stabilising element 3' with exposed rod ends 3d' bent back inwardly of upper facing panel 2b' to form a seat S for lower transverse rod 2f of the upper

facing panel 2b'. Stabilising element 3' has a transverse rod 3b' located on the outside of the lower facing panel 2b retaining the upper and lower facing panels 2b', 2b to each other and to the stabilising element.



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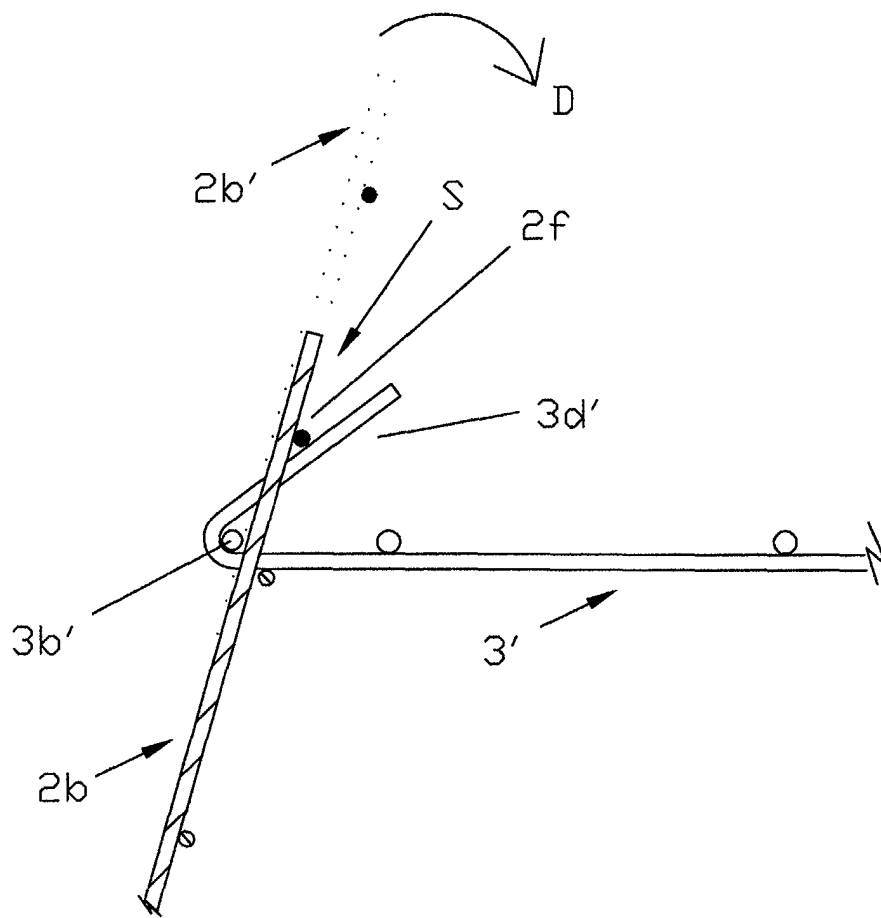


FIG 8

## Description

**[0001]** This invention relates to improvements in or relating to construction, particularly retaining wall structures and more particularly, but not exclusively, to an earthen works assembly including a retaining wall structure.

**[0002]** Earthen works assemblies are well known. Often it is necessary during building to create, for example, an earth or soil embankment or slope and some internal reinforcement of the earth or soil is needed during the creation of the embankment or slope for the stabilisation thereof both when completed and during the methodical building up of the earthen works assembly. Traditionally, such earthen works assemblies include a plurality of outwardly facing panels that may be in the form of grids or meshes which are connected to internally directed stabilising elements (which elements may also be in the form of grids or mesh panels). The stabilising elements extend through layers of earth or soil used in the earthen works assembly. Usually, the stabilising elements will be arranged to extend generally horizontally through the earthen works assembly generally defining the build-up of the layers of earth therein. Such earthen works assemblies including said stabilising elements allow an earth retaining structure to be formed having an outer face arrangeable at a steeper angle than otherwise might be possible without the use of such stabilising elements. Furthermore, such earthen works assemblies may have outer faces arranged at a very steep angle to the horizontal which, in some cases, may be vertical. Such assemblies may be required for embankments, earth retaining walls and bridge abutments.

**[0003]** The outer faces of the earthen work assemblies will usually be made up of a plurality of generally aligned facing panels that may be rigid and solid (for example they may be of concrete) or which may be flexible for example in the form of a grid such as a metal grid. The stabilising elements themselves may be in the form of strips, grids, meshes, bars or sheets that are usually attached to the facing panels. The length of the earth stabilising elements will usually be the same as the width of the mass of the reinforced earthen works. It is possible that retaining wall structures may be employed to retain a medium other than soil or earth, for example, sand or any stone or granular or aggregate mixture. It is believed that there tend to be problems or disadvantages associated with current designs of retaining wall structures or at least it is believed that such designs have not been optimised. For example, current retaining wall structures employ grid facing panels that are connected to the earth stabilizing elements by the use of separate, purpose-made fastenings that tend to be rather expensive in relation to the overall cost of the retaining wall structure and which may also require a level of dexterity or complexity in forming the finished earthen works assembly that need not be necessary and which may be unnecessarily time consuming. Fur-

ther, other retaining wall structures employ complex face panels that are also rather expensive. It is believed that it should be possible to provide a retaining wall structure which is less expensive and/or in which the ease of assembly is increased.

**[0004]** It is object of the present invention to provide a retaining wall structure and/or an earthen works assembly in which one or more of the aforementioned, or other, disadvantages associated with same is/are alleviated and/or to provide a retaining wall structure and/or earthen works assembly which is improved in at least some respect.

**[0005]** According to the present invention there is provided a retaining wall structure for an earthen works assembly or the like comprising at least two facing panels connected together, in use, by at least one stabilising element, the stabilising element engaging, or passing through, or being arranged to exert a holding force on, an outer face of at least one of said facing panels, said outer face, in use, being remote from, or facing away from, an earth fill or other fill medium contained by said earthen works assembly or the like.

**[0006]** Further according to the present invention there is provided an earthen works assembly or the like including a plurality of retaining wall structures as defined in the immediately preceding paragraph.

**[0007]** Further according to the present invention there is provided a method of building a retaining wall structure for an earthen works assembly or the like, said method comprising introducing at least two facing panels adjacent to one another and connecting them together by at least one stabilising element engaging or passing through or exerting a holding force on an outer face of at least one of said facing panels, said outer face being remote from, or facing away from, an earth fill or other fill medium being introduced into said earthen works assembly or the like.

**[0008]** In one embodiment of the retaining wall structure, the stabilising element has a retaining part, preferably, in the form of a transverse member or rod, which is, in use, arranged outwardly beyond said outer face of at least one of the facing panels. The transverse member or rod may be an integrally made part of said stabilising element or may be a part fixed thereto e.g. by welding either prior to assembly with said at least one facing panel or whilst the stabilising element and facing panel are in situ with one another (i.e. during building of said earthen works assembly or the like). In this way, the transverse member or rod (which will usually be an end member or rod) should be able to restrain or prevent outward movement of said at least one of said facing panels relative to said stabilising element due to outward pressure of the earth fill material used in the earthen works assembly or the like (said earth fill material covering the stabilising element).

**[0009]** Usually, the stabilising element will engage, or pass through, or be arranged to exert a holding force on each of said at least two facing panels and one of said

at least two facing panels (usually a lower one of said two panels) may have a transverse member or rod arranged, in use, to restrain or limit inward movement of the other one of said two panels at least adjacent to said stabilising element (usually at a lower end of the upper one of said two panels).

**[0010]** The retaining wall structure may be provided with separate locking means e.g. in the form of a locking member or bar (preferably a flexible or bendable rod) that can be utilised to restrain or limit pivoting of one of said at least two facing panels (usually inwardly of the earthen works assembly in use) relative to said other one of said at least two facing panels and/or stabilising element. The locking member or bar may be threaded in and out of portions of each of said at least two facing panels at a location spaced from the stabilising element.

**[0011]** Advantageously, instead of separate locking means being provided to restrain /limit said pivoting as aforesaid, the stabilising element itself may be configured to provide said locking or restraining function. In one embodiment, the stabilising element is arranged to extend outwardly beyond said at least one facing panel and back inwardly inside the other one of said at least two facing panels to support the last mentioned panel and restrain/limit said inward pivoting. In this manner, an additional seat or seating may be provided for said otherwise pivotable panel. Additionally, in such an arrangement, where the stabilising element has a retaining part/ transverse member or bar arranged outwardly beyond said at least one facing panel, the member or bar may be, advantageously, located snugly in the apex of the bent back or angled back part of the stabilising element so that the strength of the holding force will not rely entirely of the strength of connection (for example weld strength) of the transverse member/ bar to the stabilising element. In fact, owing to the configuration of the stabilising element, for ease of assembly, it is preferred that the retaining part/transverse member is separate from the remainder of the stabilising element, since there is no longer a necessity for it to be a fixed or integrally-formed part of the stabilising element.

**[0012]** The facing panels and/or stabilising element may be of grid-like or matrix structure, ( e.g. made up from welded rods) and preferably, each of the at least two facing panels has a series of projections ( e.g. rod ends) which overlap one another, in use, in an earthen works assembly or the like and which preferably extend through the stabilising element ( e.g. through openings or apertures defined in the stabilising element, such as rectangular apertures defined in the stabilising element more particularly where the stabilising element is made up of rods).

**[0013]** Where the stabilising element has a series of projections and is configured to provide the locking or restraining function, the projections may be bent or angled backwardly to extend inwardly of the associated panel to be supported. It is believed that such an arrangement is advantageous from a safety aspect since

the potential hazard of a stabilising element with sharp ends projecting outwardly beyond said at least two facing panels may be avoided.

**[0014]** Further according to the present invention there is provided a retaining wall structure for an earthen works assembly or the like comprising at least two panels connected together in use by at least one stabilising element without the aid of separate, purpose-made fasteners or fastening means (such fasteners or fastening means usually extend or are required to extend inwardly of the at least two panels and/or are located in between an inner face of one or more of said two panels and an end of the stabilising element and/or have relatively movable parts).

**[0015]** Many advantageous features of the present invention will be evident from the following description and drawings.

**[0016]** Embodiments of a retaining wall structure in accordance with the present invention, for example, for an earthen works assembly, will now be described, by way of example only, with reference to the accompanying, somewhat diagrammatic drawings in which:

FIGURE 1 - Shows a much simplified isometric view of the first embodiment of the retaining wall structure;

FIGURE 2 - shows to a larger scale an isometric view of part of the retaining wall structure shown in FIGURE 1;

FIGURE 3 - shows to an enlarged scale part of the retaining wall structure of FIGURE 1 (and additional locking bar) looking in the direction of arrow A in FIGURE 1 which, in use, will be from outside an earthen works assembly;

FIGURE 4 - shows a side view of a central portion of the retaining wall structure shown in FIGURE 3, looking in the direction of arrow B;

FIGURES 5 and 6 - show views similar to FIGURE 4 but with upper and lower facing panels of the retaining structure being engaged differently with one another;

FIGURE 7 - shows a view similar to FIGURE 3 of a second, preferred embodiment of the retaining wall structure;

FIGURE 8 - shows a side view of a portion of the retaining wall structure shown in FIGURE 7 looking in the direction of arrow C in FIGURE 7;

FIGURES 9a to 9d - show diagrammatically a series of steps illustrating a sequence of construction of an earthen works assembly in accordance with the present invention;

FIGURE 10 - shows a view similar to part of FIGURE 1 in which a stabilising element of the retaining wall structure has been modified;

FIGURE 11 - shows various alternative forms of stabilising elements, and

FIGURE 12 - shows an earth stabilising element which is in the form of a grid engaging a facing panel

of a retaining wall structure.

**[0017]** Referring to FIGURES 1 and 2 of the drawings, a retaining wall structure 1 for an earthen works assembly (see FIGURES 9a to 9d) includes a plurality of grid-like facing panels 2 arranged in generally the same plane and substantially at right angles to a plurality of horizontally and vertically spaced stabilising elements 3 which extend in the direction inwardly of an earth fill of an earthen works assembly or the like. FIGURE 1 shows four facing panels 2 in vertical alignment whereas FIGURE 2 only shows parts of two adjoining facing panels 2b,2b'.

**[0018]** Although the facing panels 2 are shown extending at right angles to the stabilising elements in FIGURES 1 and 2, this angle may be chosen to suit; usually the stabilising elements 3 will be arranged horizontally and the facing panels 2 at a relatively steep angle (for example 60 or 70 degrees to the horizontal). The grid format of the panels 2 and stabilising elements may be chosen to suit.

**[0019]** As shown in FIGURES 1 and 2, each stabilising element 3 comprises a grid defining rectangular apertures 3a which are of somewhat larger dimensions than the rectangular apertures 2a of the facing panels 2 (the facing panels 2 and stabilising elements 3 may be of any convenient format and/or construction and may for, example, be of a metal or polymer material). In the present embodiment, the facing panels 2 are made up of a first set of parallel, metal rods equidistantly spaced from one another which are welded to a second set of rods arranged at right angles to the first and in parallel equidistant relationship. The stabilising elements 3 are made up in a similar manner.

**[0020]** The manner in which the stabilising elements 3 are connected to the facing panels 2 should be generally evident from FIGURES 1 and 2 of the drawings. Initially, as shown in FIGURE 2, a lower facing panel 2b of specified length is arranged to extend generally upwardly (vertically or otherwise) from a floor or floor level stabilising element (not shown in FIGURES 1 and 2). A stabilising element 3 (see FIGURE 2) is introduced towards the lower upright facing panel 2b in a generally horizontal position and is lowered onto said lower facing panel with a series of projections in the form of the exposed, upright rod ends 2c of panel 2b extending through the respective apertures 3a defined at the end of the stabilising element 3 adjacent the facing panel 2b. The stabilising element 3 rests with the end transverse rod 3b supported by and adjacent to the upper, parallel transverse rod of the lower facing panel 2b. Thus, the stabilising element 3 is generally free to swing about an axis X-X shown in FIGURE 2. Thus, it should be clear from FIGURE 2 that the end transverse rod 3b extends outwardly beyond the lower facing panel 2b and the horizontal internally directed parallel rods 3c have exposed rod ends 3d extending beyond rod 3b and beyond the lower facing panel 2b. Subsequently, a series of projec-

tions in the form of the lower, exposed rod ends 2e of the upper facing panel 2b' can be introduced in a downward direction in between the rod 3b of stabilising element 3 and the upper transverse rod 2d of the lower facing panel, generally as shown in FIGURE 2.

**[0021]** Thus, the upper and lower facing panels 2b', 2b are connected together by the stabilising element 3 which engages the exposed rod ends 2e and 2c of the upper and lower stabilising elements to exert a generally inward holding force on said facing panels from the exterior of the facing panels remote from, or facing away from, earth or the like, in use, retained by the retaining wall structure 1.. The stabilising elements 3 pass beyond the exterior of the facing panels 2 unlike in prior art arrangements which rely on the stabilising elements being fastened to a separate, purpose-made connector means which is in turn connected to the facing panels.

**[0022]** It is believed that the simple interfitting arrangement of stabilising elements 3 with facing panels 2 is a much more convenient and inexpensive way of connecting the stabilising elements to the facing panels.

**[0023]** FIGURES 3 and 4 help to more clearly illustrate the connection of lower and upper facing panels 2b,2b' with a stabilising element 3.

**[0024]** Additionally, FIGURES 3 and 4 show the use of a locking rod or bar 4 (not shown in FIGURES 1 and 2). FIGURE 4 illustrates a side view of an upper rod end 2c passing upwardly (at an angle to the vertical) in between transverse rod 3b of a stabilising element 3 and upwardly spaced lower transverse rod 2f of the upper facing panel 2b'.

**[0025]** The stabilising element 3 is engaged over the lower facing element 2b prior to downward insertion of the lower end of the upper facing panel 2b' in between rod 3b of stabilising element 3 and rod 2d of the lower facing panel 2.

**[0026]** In order to prevent the upper facing panel from swinging or pivoting inwardly of the structure about axis X-X in the direction of arrow D, the locking member or bar 4 (not shown in FIGURE 4) may be threaded in between some of the upper exposed rod ends 2c of the lower facing panel 2b and adjacent downwardly depending rods 2g of upper facing panel 2b' in the manner which is shown in FIGURE 3 of the drawings.

**[0027]** If desired, the upper facing panel 2b' may be retained to the lower facing panel 2b by means of the stabilising element 3 in a slightly different manner. FIGURES 5 and 6 illustrate two possible different variations on the manner in which the upper facing panel 2b' can be positioned differently to the lower facing panel 2b and still be retained by stabilising element 3. However, these would not be the normally adopted retaining configuration for upper and lower facing panels 2b',2b and, therefore, will not be further described.

**[0028]** It is to be noted in the embodiments already described that the rod 3b is fixed relative to the stabilising element 3 but the present invention is not limited to the retaining part (rod 3b) or the retaining means of the

stabilising element which extends beyond the facing panels being fixed to the remainder of the stabilising element, at least prior to assembly of the stabilising element with the facing panels.

**[0029]** FIGURES 7 and 8 illustrate one such embodiment of the present invention which is indeed the preferred embodiment of the invention.

**[0030]** FIGURE 7 is a view similar to FIGURE 3 which shows a modified form of stabilising element 3' and in which a separate locking bar 4 is not required. In this arrangement, the stabilising element 3' has exposed rod ends 3d' that are bent backwardly at less than 90 degrees (preferably at about 45 to less than 90 degrees, depending on the angle of the slope of the associated face of the earthen works assembly) to the main plane of the stabilising element to extend inwardly of the retaining wall structure and inwardly of the facing panels 2. The rod ends 3d' may be bent to extend at any convenient angle to the main plane of the stabilising element 3. The stabilising element 3' may be introduced over the lower facing panel 2b in a manner as previously described and the upper facing panel 2b' introduced therebetween in a similar manner as previously described except that now the exposed rod ends 3d' extend inwardly beyond the upper facing panel 2b' to provide a V-shaped seat S for the lower transverse rod 2f of the upper facing panel 2b' (thereby obviating the need for a separate locking bar 4 to prevent or limit inward swing of the upper facing panel 2b' in the direction of arrow D). Additionally, it is believed that this form of stabilising element 3 is advantageous over the form of previous stabilising elements already discussed since the rod ends 3d' are bent back into the earthen works structure in use and during construction rather than leaving any potentially sharp exposed rod ends 3d, therefore improving the safety aspects of the retaining wall structure. 1 Additionally, as aforementioned, the bent-back rod ends 3d' provide a seat S for the upper facing panels and avoid the need for any separate locking bars 4.

**[0031]** It is to be noted that the strength of the stabilising element 3 as shown in FIGURES 2 to 6 of the accompanying drawings relies on the strength of attachment of the end rod 3b to the remainder of the stabilising element 3 which, in the embodiment as shown, relies on the strength of the weld of the rod 3b to the remainder of the stabilising element 3. However, in the arrangement shown in FIGURES 7 and 8, the strength of the stabilising element 3 does not rely upon the strength of a weld because the transverse rod 3b' is in fact an element formed separately from the main body of the stabilising element 3. Thus, the stabilising rod 3b' could be inserted into the remainder of the retaining wall structure in the position as shown after the stabilising element 3' has been positioned over the lower facing panel 2b. Thus, advantageously, it is believed the embodiment shown in FIGURE 7 or 8 offers a stronger arrangement. Of course, the rod 3b' could be a fixed element welded to the remainder of the stabilising element 3 but once

the rod end 3d' is bent back around the rod 3b', the apex of the bend would necessarily have to be displaced outwardly some distance from the rod in order to achieve the bending and thus the strength of the connection would then rely once again entirely on the weld of the rod 3b to the stabilising element 3. Whilst the rod ends 3d' could be bent relative to the main plane of the stabilizing element 3 prior to welding of the rod neatly and snugly into the apex of the bend as shown in FIGURE 8, such a method of construction may prove to be expensive. Therefore, overall, it is preferred that the rod 3b' is a separate member.

**[0032]** FIGURES 9a to 9d illustrate sequentially how an earthen works assembly E (shown part completed in FIGURES 9a to 9d) can be constructed according to the present invention using a retaining wall structure 1 generally in accordance with any one of FIGURES 1 to 8. First of all, in FIGURE 9a, a lower facing panel 2b is arranged generally upwardly relative to a floor or floor level stabilising element 3. Soil or earth G or granular or aggregate material may be introduced into the structure, in FIGURE 9b, up to a certain first level L1; next, in FIGURE 9c, a second stabilising element 3 may be introduced over the lower facing panel 2b in a manner as previously described and an upper facing panel 2b' engaged with the lower element 2 and second stabilizing element 3 as shown. It is to be noted in FIGURES 9b and 9c that the earth fill material G extends at an angle to the lower facing panel 2 and the gap P is back filled at F once the first level L1 stabilising element 3 and upper facing panel 2b have been engaged as shown (and a limited amount of earth fill material G has been introduced onto a rear portion of the stabilising element 3 to help locate same) and this sequence is repeated in order to create the earthen works assembly E. Once the earthen works assembly is finished (not shown), the facing panels 2 may be surface-finished with vegetation or any convenient cladding, or left uncovered.

**[0033]** FIGURE 10 shows a modified arrangement in which a composite stabilising element M having a first, relatively short grid portion 101 connected to an extension sheet, strip or member 100 that extends further into the body of the mass of fill material, in use, said extension sheet, strip or member being attached by compression or mechanical means to the earth stabilising element 101 by means of overlapping the ends of the extension and earth stabilising element. Grid portion 101 and the extension sheet or member 100 form together the same length as the stabilising element 3 shown FIGURES 1 and 2 of the drawings.

**[0034]** FIGURE 11 shows, by way of example, four possible alternative configurations for stabilising elements 3', 3'', 3''', and 3'''' in each case engaging a rod member R of a facing panel 2 (not shown in Figure 11).

**[0035]** FIGURE 12 shows a further alternative grid formation stabilising element 3'''' (only shown in part) engaging rods R of a facing panel 2.

**[0036]** It is to be appreciated that the present inven-

tion offers many improvements, at least some of which might be patentable individually or in combination. Any individual feature as aforementioned or as shown or implicit herein or combinations thereof, or functions or methods appertaining thereto, may be patentably inventive and any specific term as used herein should not be construed as unnecessarily or unduly limiting. The scope of such a term should extend to, or may be replaced or supplemented by, any equivalent or generic expression. The term 'wall' as used throughout this specification is used in a very general sense and is not intended to be restricted to any particular material or orientation such as 'vertical' unless otherwise specifically stated. Any range mentioned herein for any variable or parameter should be taken to include a disclosure of any derivable sub-range within that range or of any particular value of the variable or parameter arranged within, or at an end of, the range or sub-range. The singular may include the plural and vice versa.

[0037] Therefore, still further according to the present invention there is provided a reinforced earthen works assembly or the like comprising a plurality of earth stabilising elements attached to or supporting a plurality of facing panels by a transverse part or member of each stabilising element acting on an outer face of an associated facing panel or panels.

[0038] Further according to the present invention there is provided a reinforced earthen works assembly or the like comprising a plurality of earth stabilising elements attached to or supporting a plurality of facing panels, wherein an end of each stabilising element extends beyond an outer face of at least one of two associated facing panels and is bent or angled backwardly inwardly beyond the other of said two associated facing panels to support or restrain or limit (pivoting) movement of said last mentioned facing panel.

[0039] Further according to the present invention there is provided a retaining wall structure for the earthen works assembly or the like as defined in each of the two immediately preceding paragraphs and/ or a method of building such an earthen works assembly or the like.

## Claims

1. A retaining wall structure for an earthen works assembly or the like comprising at least two facing panels connected together, in use, by at least one stabilising element, the stabilising element engaging, or passing through, or being arranged to exert a holding force on, an outer face of at least one of said facing panels, said outer face, in use, being remote from, or facing away from, an earth fill or other fill medium contained by said earthen works assembly or the like.

2. A retaining wall structure as claimed in claim 1 in

which the stabilising element has a retaining part in the form of fixed or separate transverse member or rod, which is, in use, arranged outwardly beyond said outer face of at least one of the facing panels.

3. A retaining wall structure as claimed in claim 1 or claim 2 in which the stabilising element engages, or passes through, or is arranged to exert a holding force on each of said at least two facing panels.

4. A retaining wall structure as claimed in any one of the preceding claims in which the stabilising element is arranged to extend outwardly beyond said at least one facing panel and back inwardly inside the other one of said at least two facing panels.

5. A retaining wall structure for an earthen works assembly or the like comprising at least two panels connected together in use by at least one stabilising element without the aid of separate, purpose-made fasteners or fastening means.

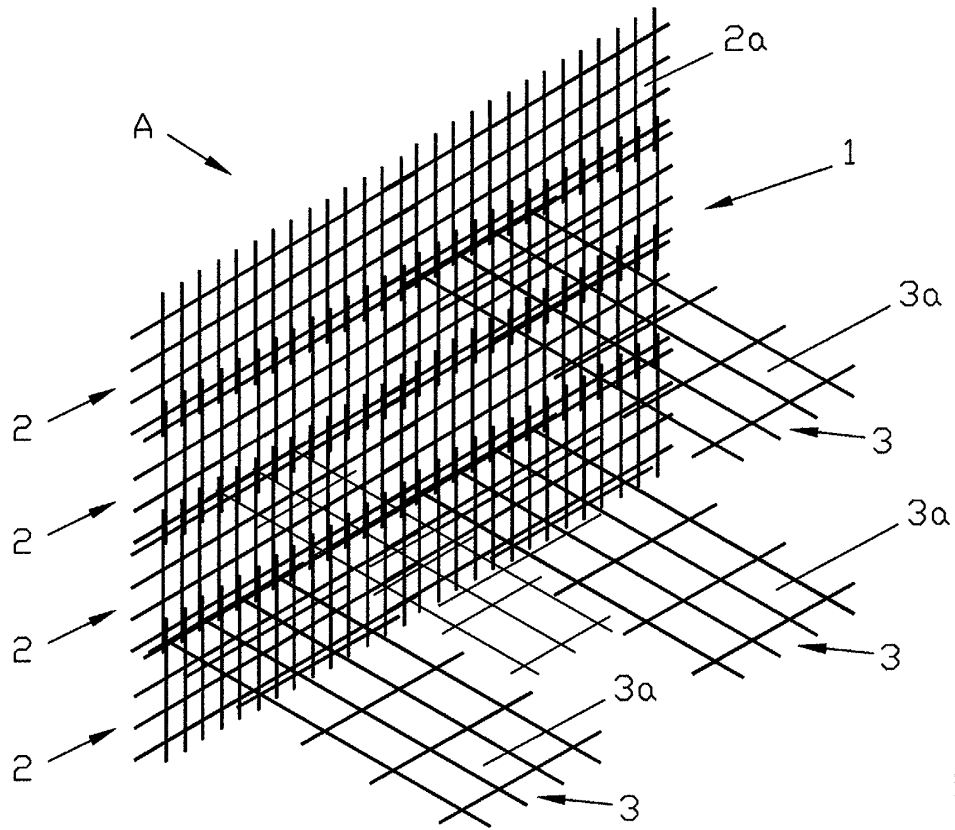


FIG 1

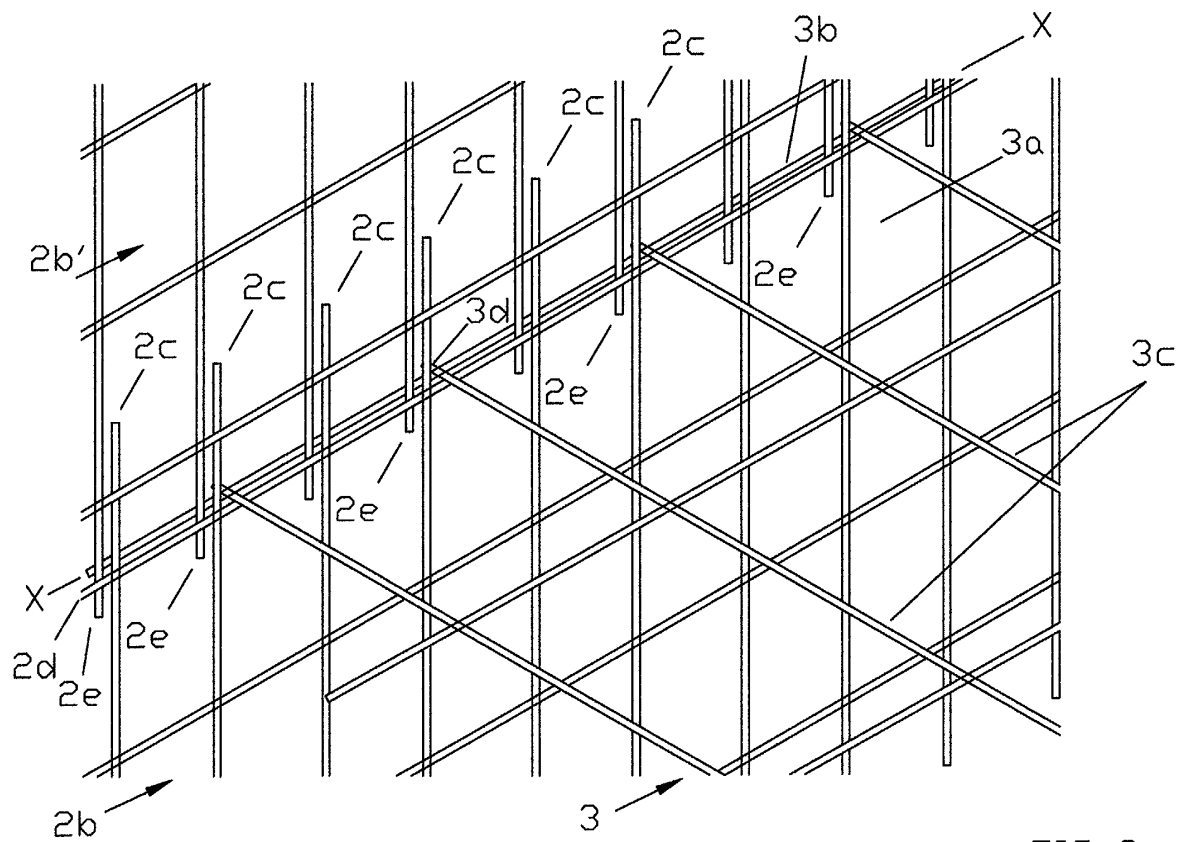


FIG 2



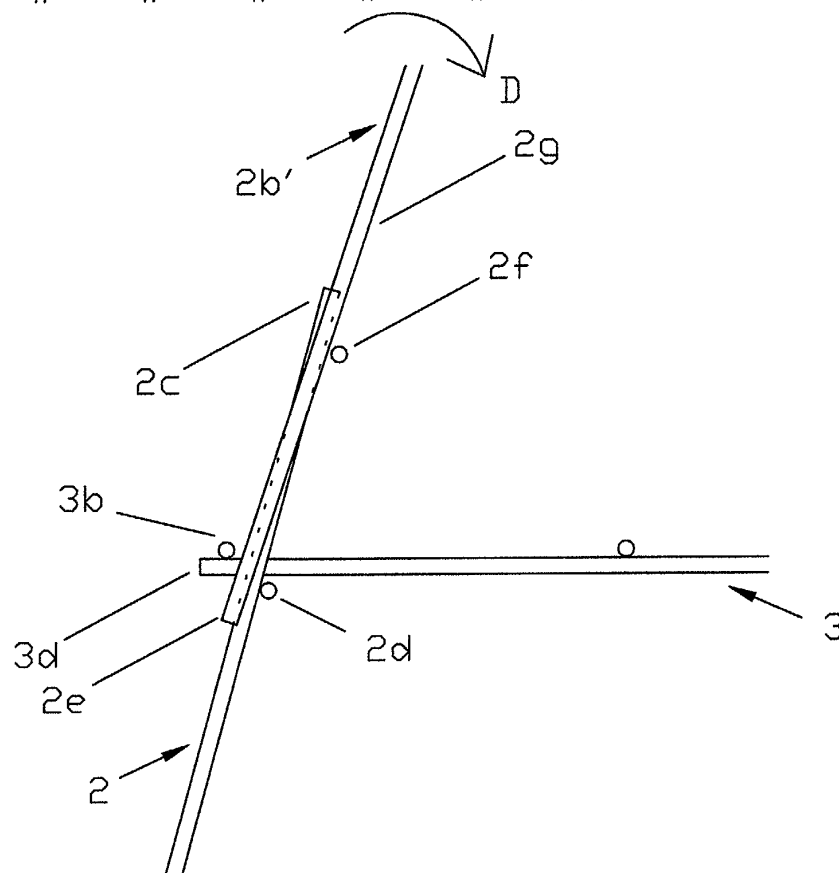
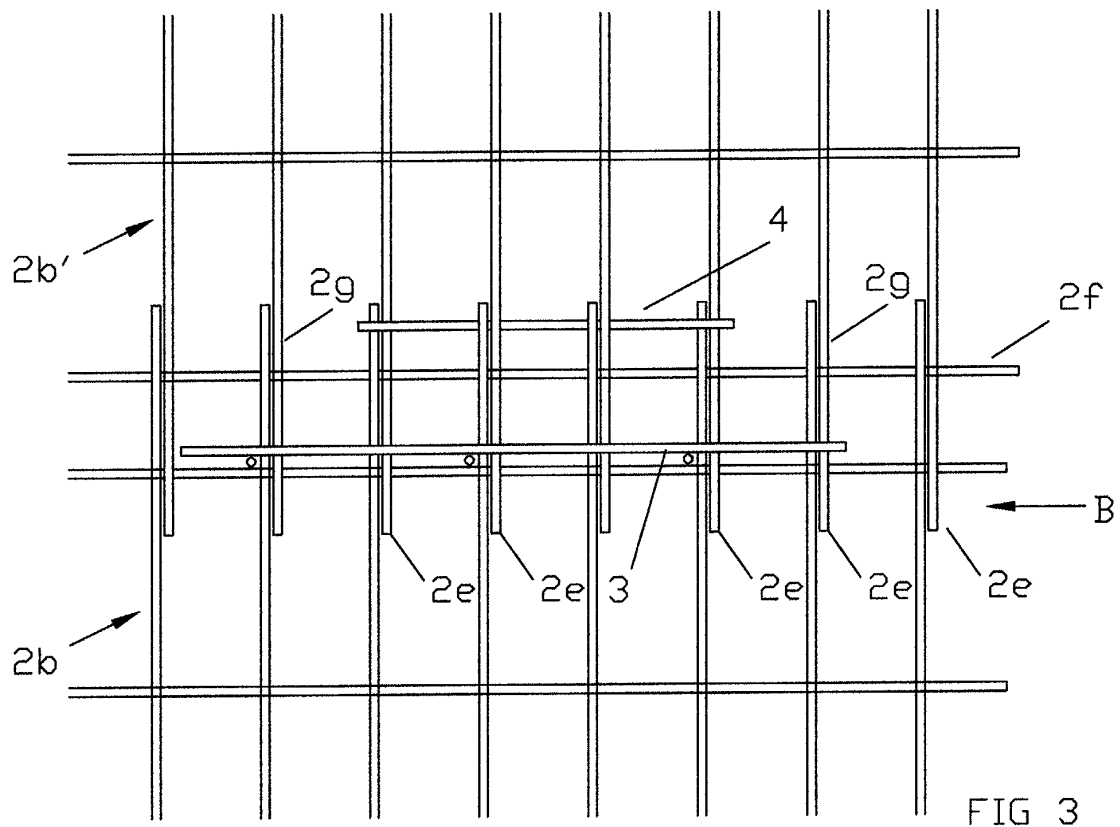


FIG 4

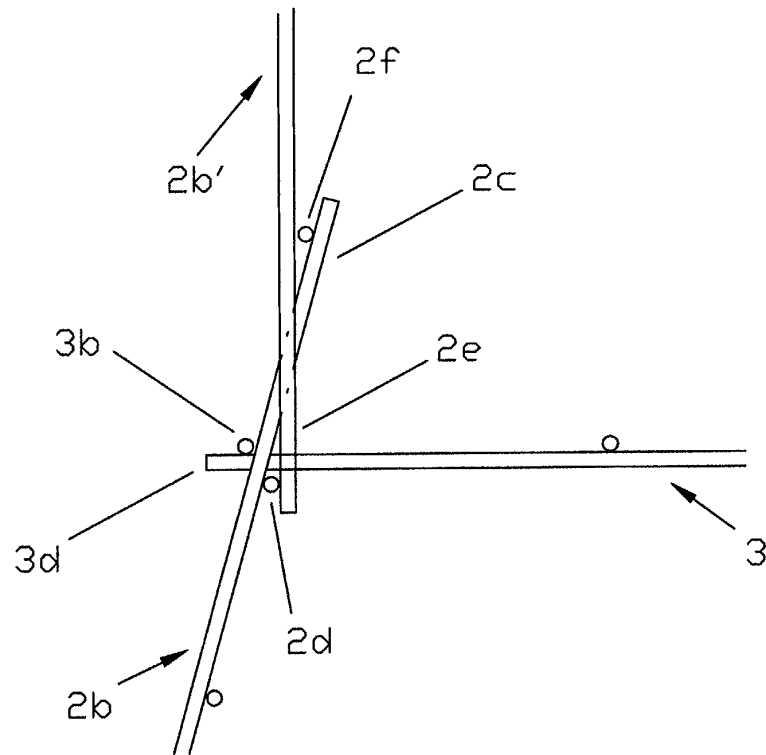


FIG 5

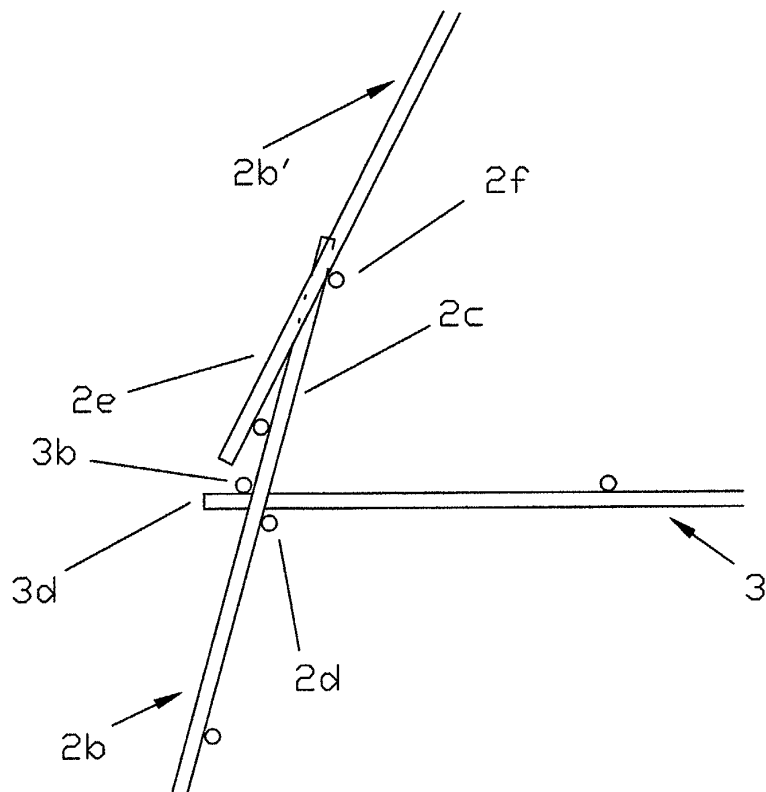


FIG 6

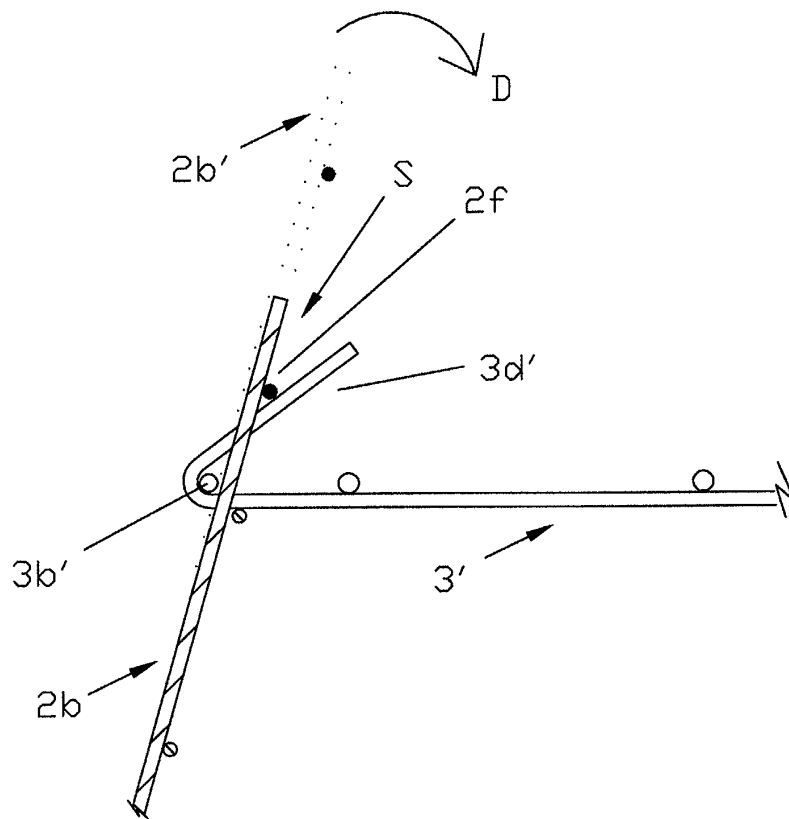
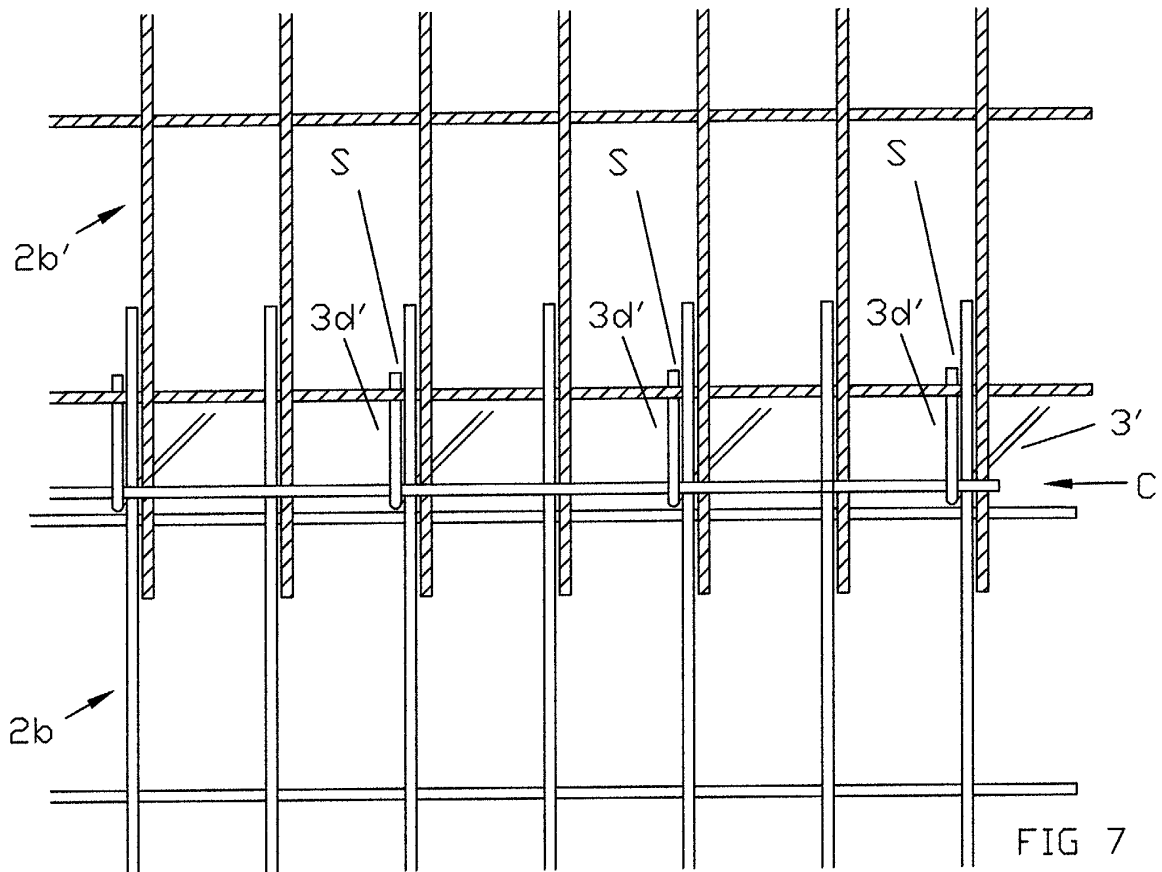


FIG 8

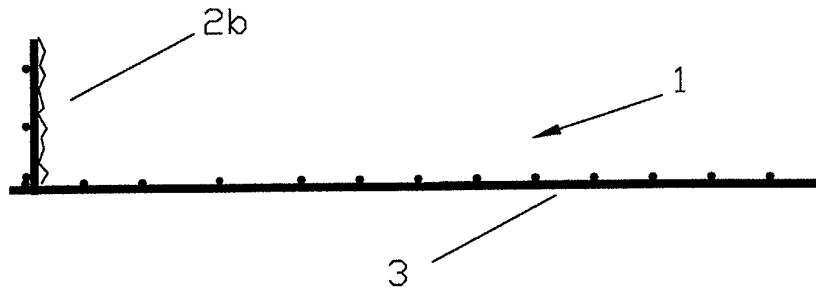


FIG 9a

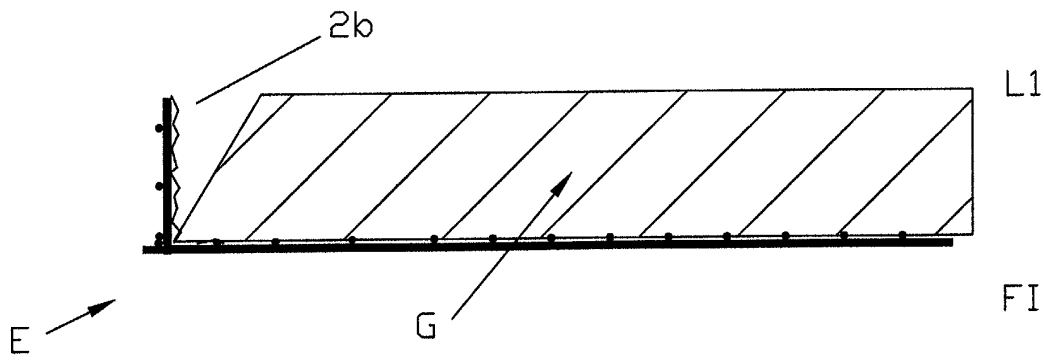


FIG 9b

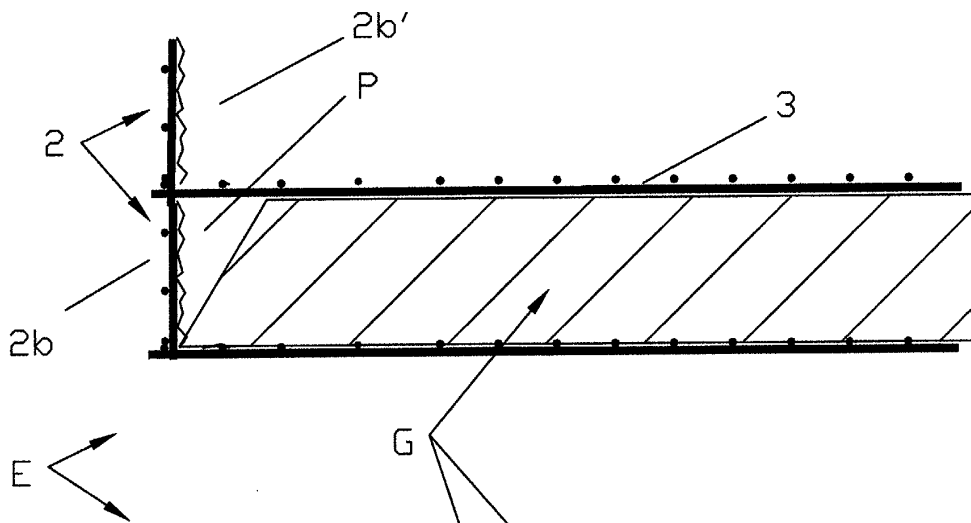


FIG 9c

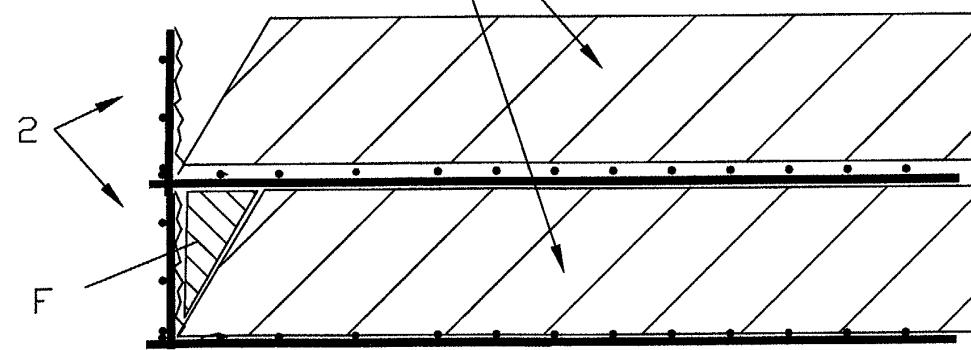


FIG 9d

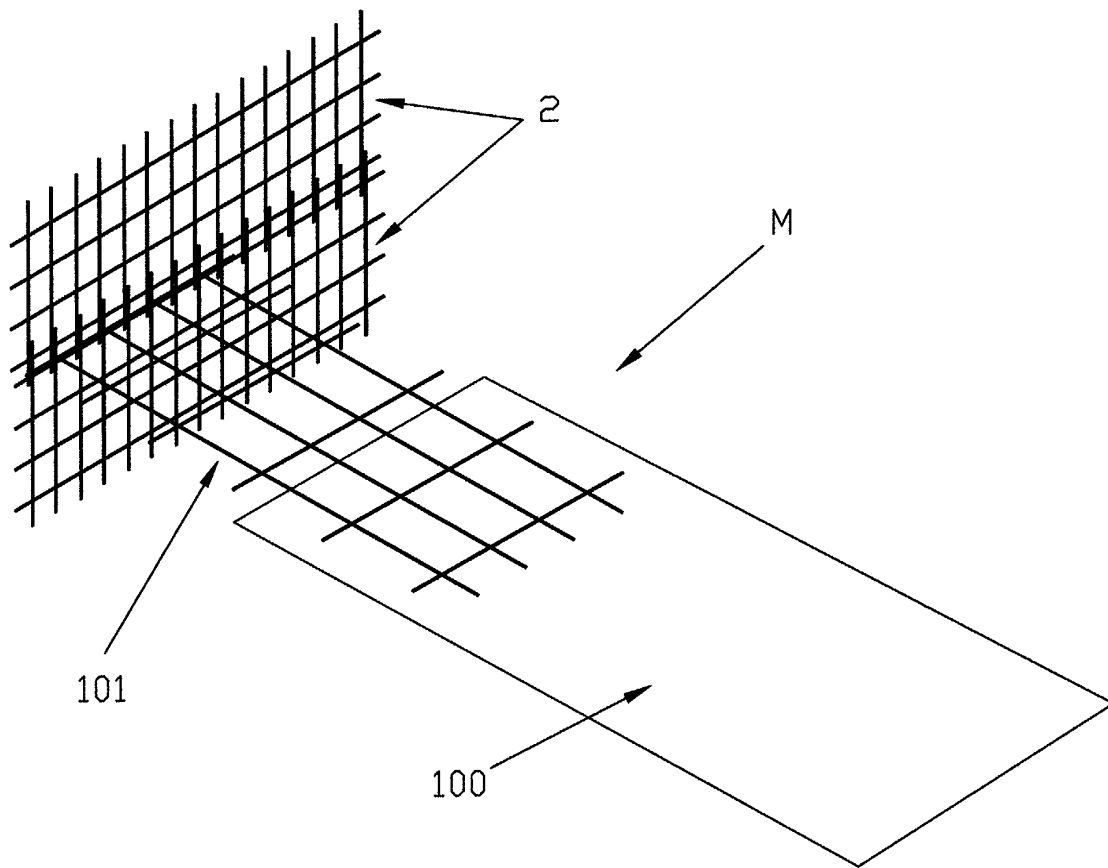


FIG 10

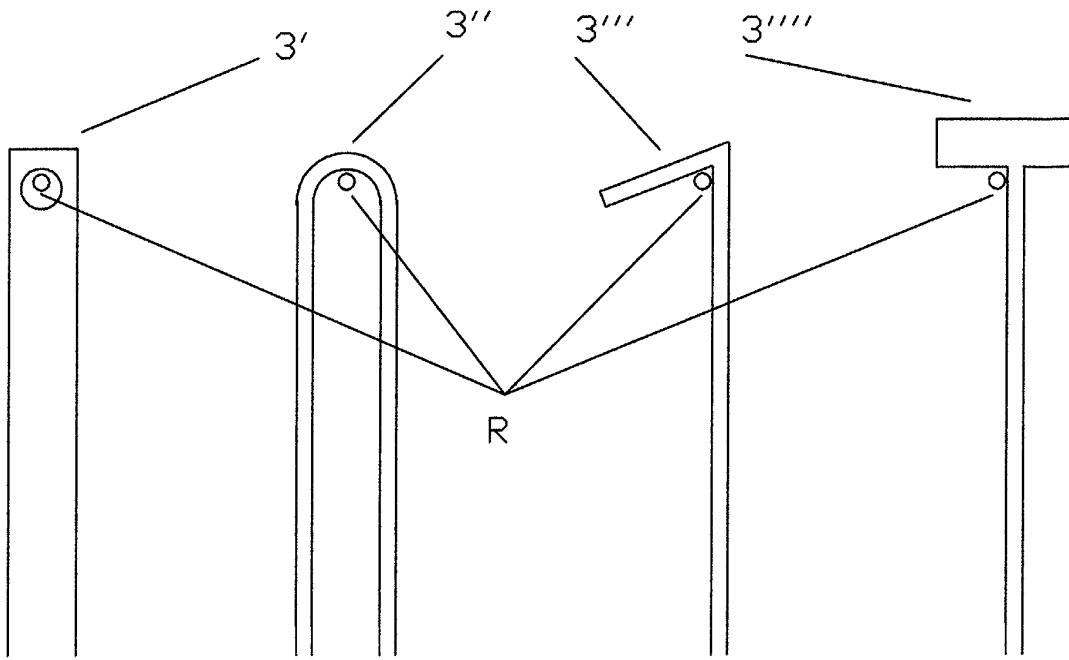


FIG 11

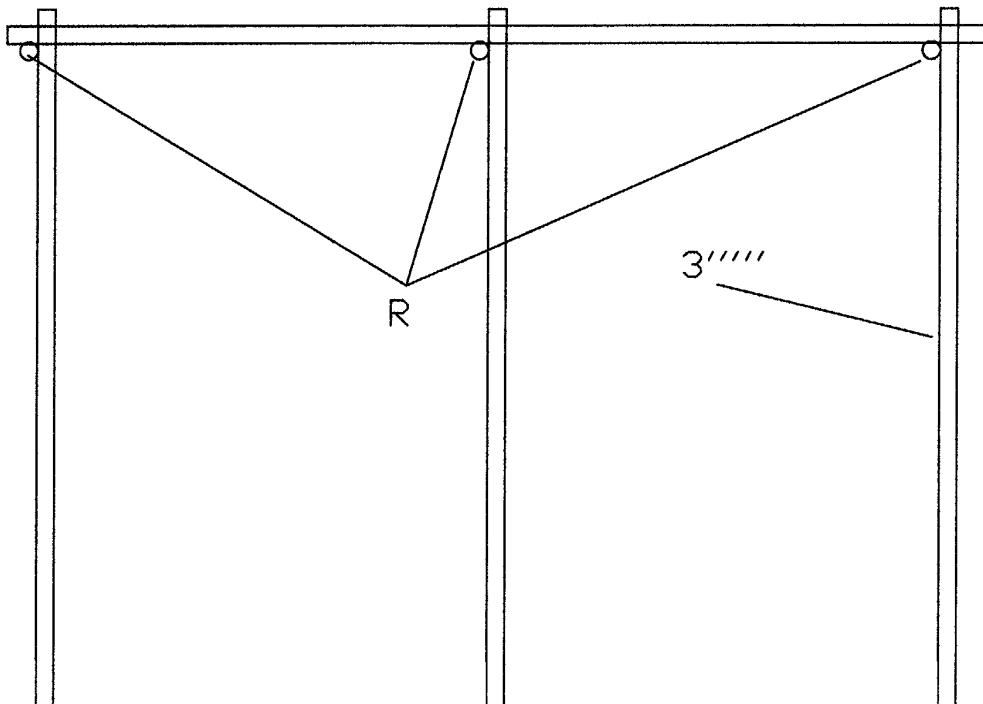


FIG 12



European Patent  
Office

# EUROPEAN SEARCH REPORT

Application Number  
EP 02 25 3503

| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                              |                   |                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|-------------------|----------------------------------------------|
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Citation of document with indication, where appropriate, of relevant passages                                                                | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int.Cl.7) |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | US 6 086 288 A (SWANSON DAVID ET AL)<br>11 July 2000 (2000-07-11)<br>* column 10, line 52 - line 57; figures 17-20 *                         | 1-6               | E02D29/02                                    |
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