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(54) **GRID FOR STRUCTURAL REINFORCEMENT**

(57) The invention relates to a grid for structural reinforcement (2) which comprises a first series of rods (4) and a second series of rods (6). The rods (4) of the first series are arranged essentially parallel among each other; the rods (6) of the second series are arranged essentially parallel among each other and essentially orthogonally with respect to the rods (4) of the first series. The rods (4, 6) of one of the series pass at the crossing points (8a, 8b) created between the two series of rods (4, 6) in an alternating way over and under the rods (6, 4) of the other series. At the crossing points (8a, 8b) the rods (4, 6) are connected among each other and have a reduced thickness with respect to the basic thickness of the rod (4, 6). The reduced thicknesses are represented by flattenings of the rods at the crossing points (8a, 8b) which each comprise a recess (10) and a flat portion (12) of the rod (4, 6) wherein the flat portion (12) is widened in the plane of the grid with respect to the cross section of the basic rod and wherein the recesses (10) open in an alternating manner in opposite senses in the direction orthogonal to the grid plane. The invention further concerns a reinforced construction material which comprises a hydraulic binder, preferably selected among mortar, concrete, cement and other cementitious materials as matrix and a grid for structural reinforcement (2) according to the invention embedded in the matrix of hydraulic binder. It is also described a use of the grid for structural reinforcement (2) according to the invention to stabilize asphalts or soils, in particular slanting grounds.

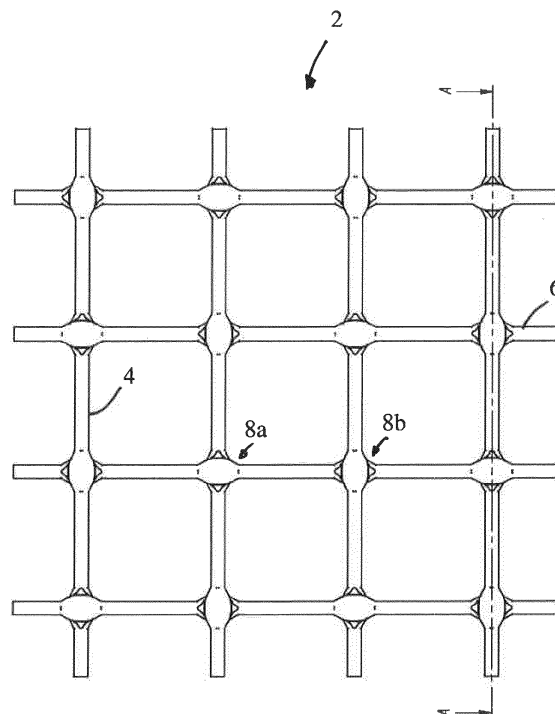


Fig. 3a

Description

TECHNICAL FIELD

[0001] The invention relates to a structural grid, for example made of composite material, for use in the construction industry and in construction in general. The proposed grid is an alternative and an improved variant compared to traditional grids of ferrous material. The structural grid of the invention is applied in hydraulic binders, such as mortar, concrete, and other cementitious materials to create structures such as reinforced concrete or reinforced concrete conglomerate. The proposed structural grid is also suitable to be used to reinforce asphalt or soil, especially sloping grounds.

STATE OF THE ART

[0002] The grids for structural reinforcement, also known as structural grids, currently on the market are formed by rods or metal round bars that overlap each other, obtaining a double grid thickness with respect to the used round bar. With a thickness "s" of the round bar, a grid thickness of $2 \times s$ is obtained.

[0003] Generally in the traditional structural reinforcement grids, the overlapped rods (illustrated with reference to Figures 1a and 1b) are not intertwined, but a series of parallel spaced round bars is superimposed by another series of parallel spaced round bars arranged orthogonally with respect to the first series of round bars, where the round bars of the two series cross each other and are electrically welded together in the so-called knots to form a grid structure. Such an arrangement implies that the strength of the knot is given by the strength of the fastener which holds two round bars together at the point of intersection.

[0004] There are also grids made of plastic round bars that try to replicate the electro-welded metal grids in which the crossings of the round bars are tied by various materials, from ties with wire to those with plastic straps or plastic seals, and in any case with materials that usually are other than those used for the grid itself.

[0005] Then there are non-structural interwoven grids (as illustrated hereinafter with reference to Figure 2) in which a group of fibers or fiber bundles is arranged in a parallel form, and in which the fibers or the fiber bundles have holes arranged in a manner such that they are aligned between the individual fibers. A second series of fibers or fiber bundles is inserted into the aligned holes to intertwine the fibers or fiber bundles thereby forming a grid. Usually the fibers are made of support material. The type of intertwining created means that the mechanical strengths in the two senses of the grid are not the same, being the strength along the fibers or bundles of perforated fibers greater than the strength along the fibers or fiber bundles inserted in the holes.

[0006] Document WO 03/002821 A1 describes another example for grid reinforcements for building and road

constructions which has been designed to improve the adhesion of a cover of a surface to that surface.

DISCLOSURE OF THE INVENTION

[0007] The object of the invention is to propose a grid for structural reinforcement, in particular to be used in combination with hydraulic binders in the building sector, which overcomes the aforesaid drawbacks, and which precisely reduces the volume occupied by the grid, and which has a uniform mechanical resistance in both senses of the grid.

[0008] The object is achieved by a grid for structural reinforcement which comprises:

- (a) a first series of rods; and
- (b) a second series of rods;

wherein

- (i) the rods of the first series are arranged essentially parallel among each other;
- (ii) the rods of the second series arranged essentially parallel among each other, and essentially orthogonally with respect to the rods of the first series;
- (iii) the rods of a series pass at the crossing points created between the two series of rods in an alternating way over and under the rods of the other series,
- (iv) at the crossing points the rods are connected among each other; and
- (v) at the crossing points the rods of both series have a reduced thickness compared to the basic thickness of the rod wherein the reduced thicknesses are represented by flattenings of the rods at the crossing points, which each comprise a recess and a flat portion of the rod in which the flat portion is widened in the grid plane with respect to the section of the basic rod and in which the recesses open in an alternate form in opposite senses in the direction orthogonal to the grid plane.

[0009] Ideally, the rod keeps the section area of the base section of the basic rod in the flat portion. The widened areas provide mutual support zones at the crossing points and increase the surface useful for the connection between the rods.

[0010] The grid according to the invention therefore comprises a plurality of longitudinal rods (running rods) and a plurality of rods (brackets) arranged transversally to the longitudinal rods. The longitudinal and transverse rods are intertwined to each other. The grid according to the invention is a building scaffolding. The characteristic of the reduced thickness at the crossing points results in obtaining an overall thickness (height in the direction orthogonal to the grid plane) of the grid which is less than the sum of the thicknesses of two superimposed rods, and in the preferred case corresponds to the thickness

of a single rod. Given a thickness "s" of the rod, in the preferred case a grid thickness equal to "s" is obtained. In the case of round bar-shaped rods, the thickness corresponds to the diameter of the round-section round bar.

[0011] Thanks to the reduced and uniform thickness across the entire grid, the grids according to the invention occupy half the volume of the same traditional dimensions, so that the transport by volume costs half. If half the volume is occupied, less concrete and/or mortar is sufficient to cover it.

[0012] The particular type of interweaving (that is, speaking in the language of weaving, therefore, alternate passages of the warp "above" and "below" the weft) allows to obtain in the grid an equal mechanical strength in both senses of the grid, and the strength of the crossing point it is not (only) given by the strength of the binder which holds the two rods together at the crossing point, but in the case of the intertwined grid according to the invention the stress is also distributed to the adjacent crossing points/knots.

[0013] In a most preferred embodiment of the invention, the configuration of the two series of rods follows a plain weave. Such a weave is highly regular and stable and allows the distribution of the applied force on a crossing point also to the four adjacent points. In an alternative variant embodiment, which is less preferred as regards the distribution of forces from one intertwining point to the others, it is a basketweave or panama-type weave. Other types of weaving are conceivable, such as textures known in the fabric area.

[0014] Advantageously, the rods are selected from round bars, fibers or fiber bundles. Round bars mimic the usual circular rods in ferrous grids of the state of the art. For reasons of mechanical strength, it is preferable that the rod comprises fibers whose length corresponds preferably to the length of the rod itself.

[0015] In this regard, in a preferred embodiment of the invention, the rods are composed of a composite material formed from a fiber support and a resin matrix which joins the fibers of the support. The support determines the mechanical strength. Advantageously, the support may be of different materials depending on the characteristics to be obtained, but which in general use is preferably represented by glass, carbon and/or basalt fibers. The resin matrix, in turn, can have different bases depending on the uses to which the final product is intended, but which in general use is advantageously represented by polyester, epoxy and vinylester resins. Other materials for rods, such as metals, are conceivable.

[0016] Grids made of composite material weigh less than a third of the traditional iron grids. An operator is sufficient to move a standard grid of dimensions 2 x 3 m with a diameter of 6 mm that weighs 7.5 kg, while according to the Italian legislative decree n°81/08 and its subsequent modifications and additions two operators need to move the same iron grid that weighs 26 kg. This advantage of the grid according to the invention can be obtained even for a grid having dimensions 2 x 3 m with

a diameter of 10 mm which weighs 20 kg. The composite material does not rust. Grids made of composite material have a coefficient of expansion similar to concrete, minimizing cracks due to different expansions between hydraulic binder and structural grid. The iron, due to the difference in thermal expansion and rust, tends to crack the cement, weakening the structure over time. The composite material is resistant to salt and acid corrosion (acid rain). The composite material does not conduct electric current, and does not conduct heat.

[0017] Plastic materials without integrated fibers are less resistant, in particular less resistant to traction, and are more resilient.

[0018] Preferably, at the crossing points the rods are fixedly connected by a glue material whose base is the same as the resin matrix of the rod itself. Links of this kind are less complex and require less materials than the state of the art. The welding between one rod and the other could also be obtained by heating the crossing points thus melting the rod matrix partially. Advantageously, the reduced thickness corresponds to half the basic thickness of the rod. Lower reductions of the basic thickness of the base resulting in lower savings in the height of the grid are also conceivable.

[0019] For a high uniformity in the distribution of the stability and mechanical strength of the grid, the rods essentially parallel among each other are also essentially equidistant to each other. From the production point of view, a high regularity in the configuration of the grid also simplifies the application of the reduced thicknesses on the rods, since the distribution of a series of reduced thicknesses along a rod requires relative distributions of reduced thicknesses compatible on the other rods that cross this first rod.

[0020] A second aspect of the invention relates to a reinforced building material, which comprises a hydraulic binder, preferably selected from mortar, concrete, cement and other cementitious materials as a matrix, and a grid for structural reinforcement according to the invention, which is embedded in said matrix of hydraulic binder. Such a reinforced material can be, for example, a wall, a floor or a ceiling of a building, such as a house, a gallery or a bridge.

[0021] A further aspect of the invention relates to the use of the grid for structural reinforcement according to the invention in asphalts or soils, in particular slanting grounds. The inventors have observed that the grid according to the invention can also help to stabilize asphalt casting or soils.

[0022] The features described for one aspect of the invention may be transferred *mutatis mutandis* to the other aspect of the invention.

[0023] In summary, it can be seen that the invention achieves the above objects, and in particular provides a grid for structural reinforcement and a related hydraulic binder reinforced with said grid, in which the volume occupied by the grid (as well as its weight) is reduced with respect to known grids of the state of the art. Moreover,

the grids according to the invention have a uniform mechanical strength throughout the entire grid and offer the possibility of distributing loads applied on a crossing point also on crossing points adjacent to it. These advantages are due to the particular intertwined structure of the grid (influence on the mechanical strength) and to the areas of reduced thickness (influence on the volume of the grid). In fact, using the terminology of the world of fabrics, the grid has the weft and warp intertwined to each other. The weft corresponds to the longitudinal rods and the warp to the cross rods. In the plain weave type reinforcement, each round bar is arranged in an alternating way over and under the rods that intersects orthogonally. Each rod at the crossing point has a reduced thickness, in particular it widens and flattens, and the thickness in the preferred case is reduced to half the original thickness or base of the rod, so that each cross has a thickness equal to the thickness of the rod used to realize the grid.

[0024] The basic thickness of the rod is understood as the thickness that is found along the whole rod except in the flattening areas.

[0025] Said objects and advantages will be better highlighted during the description of a preferred exemplary embodiment of the invention given, by way of example and not of limitation.

[0026] Variants of the invention are the object of the dependent claims. The description of the preferred exemplary embodiment of the structural grid and the reinforced material according to the invention is given, by way of example and not of limitation, with reference to the attached drawings.

DESCRIPTION OF A PREFERRED EMBODIMENT EXAMPLE

[0027]

Figs. 1a, b show a ferrous reinforcement of the state of the art.

Fig. 2 shows a photograph of a non-structural grid made of interwoven reinforced plastic material of the state of the art.

Figs. 3a,b show an exemplary embodiment of the grid for structural reinforcement according to the invention in a top view (Fig. 3a) and in section (Fig. 3b) along the A-A line of Figure 3a.

Figs. 4a-c show axonometric views of the grid (Fig. 4a) of Figure 3a and two corresponding single rods (Figs. 4b and c).

Figs. 5a-c show orthogonal projections of a rod of the grid of Figures 3a to 4c, and in particular a side view (Fig. 5a), a top view (Fig. 5b) and a view in the direction of the longitudinal extension of the rod shown (Fig. 5c).

[0028] Figure 1a illustrates a ferrous reinforcement **1** of the state of the art, as already mentioned at the be-

ginning. A series of parallel longitudinal round bars **3** is superimposed by a series of transversal round bars **5** thus creating a grid **1** with crossing points **7** between the two series of round bars **3**, **5** in which the transversal round bars **5** all pass over the longitudinal round bars **3**, clearly visible in the section along line A-A of Figure 1a shown in Figure 1b. At the crossing points **7**, the round bars **3**, **5** are electrically welded therebetween.

[0029] Fig. 2 shows a non-structural interwoven plastic grid of the state of the art. A series of longitudinal fibers **103** forms, together with a series of bundles of transverse fibers **105**, an interwoven grid **101**. At the crossing points **107**, the transverse fiber bundles **105** pass through holes applied in the longitudinal fibers bundles **103**. This intertwining **101** has in the direction of the transverse bundles **105** a different mechanical strength with respect to the longitudinal bundle **103**, this also due to the different section of the bundles in the two senses, i.e., linear **105** and intertwined **103**.

[0030] Figures 3a and 3b illustrate an exemplary embodiment of the grid for structural reinforcement **2** according to the invention in a top view (Figure 3a) and in section (Figure 3b) along the line A-A of Figure 3a. In the grid **2** a series of longitudinal rods **4** and a series of transversal rods **6** are noted. The longitudinal rods **4** are parallel and equidistant to each other, the same is true for the transversal rods **6**. The transversal rods **6** are arranged orthogonally with respect to the longitudinal rods **4**. The arrangement of the rods creates crossing points **8a** and **8b** wherein the transversal rod **6** passes, respectively, at the crossing points with reference number **8a** above (viewed from above) the longitudinal rod **4** and at the crossing points with reference number **8b** below the longitudinal rod. The transversal rod then passes in an alternating way over and under a longitudinal rod **4** creating a plain weave configuration. In doing so, as a consequence, also each longitudinal rod **4** passes in an alternating way over and under the transverse rods **6**, which it meets along its extension. Each crossing point of type **8a** is surrounded by four crossing points of type **8b**, and vice versa. At the crossing points **8a** and **8b** the rods **4**, **6** have a reduced thickness, which results from a flattening of the rod to cause, while maintaining the section area in the area of flattening constant, the formation of a recess and an enlarged area which protrudes beyond the base extension of the rod. At the crossing points **8a**, **8b** the recesses face, a recess is then received in the other and a widened flat portion rests on the other one supporting each other. In the sectional view of Figure 3b, the recesses of the rod **4** can be clearly seen opening in an alternating way, once upwards, once downwards, each receiving a flat portion of a rod **6** in such a way that the overall thickness of the grid does not exceed the thickness of a single rod forming the grid.

[0031] Figures 4a to 4c show axonometric views of the grid (Fig. 4a) of Figure 3a and two corresponding single rods (Figs. 4b and c). Each rod **4**, **6** has equal distances of the recesses **10** caused by the formation of a flat por-

tion 12 by "crushing" the rod in the region of the crossing points 8a, 8b. To realize the plain weave, the opening of the recesses 10 opens in an alternating way in opposite directions.

[0032] The recesses 10 and the flat portions 12 in Figures 5a to 5c are better illustrated, illustrating orthogonal projections of a rod of the grid of Figures 3a to 4c, and in particular a side view (Fig. 5a), a top view (Fig. 5b) and a view in the direction of the longitudinal extension of the rod shown (Fig. 5c). At the crossing points, the flat portions 12 of two rods 4, 6 rest on top one another, creating a grid thickness s (an extension in the direction orthogonal to the plane formed by the grid itself, Fig. 5c), which corresponds to the diameter s of the rod in the non-flattened base areas of this (Figures 5a and 5b), as evidenced by the circle of Figure 5c, which represents the section of the basic rod. At the crossing points, the flattened rod extends into the plane formed by the grid itself over the base diameter of the rod.

[0033] During operation, further implementation modifications or variants, not described herein, of the grid for structural reinforcement, the reinforced building material, and the use thereof according to the invention may be implemented. If such modifications or such variants should fall within the scope of the following claims, they should all be considered protected by the present patent.

Claims

1. Grid for structural reinforcement (2) comprising:

- (a) a first series of rods (4); and
- (b) a second series of rods (6);

wherein

- (i) the rods (4) of the first series are arranged essentially parallel among each other;
- (ii) the rods (6) of the second series are arranged essentially parallel among each other and essentially orthogonally with respect to the rods (4) of the first series;
- (iii) the rods (4, 6) of one of the series pass at the crossing points (8a, 8b) created between the two series of rods (4, 6) in an alternating way over and under the rods (6, 4) of the other series,
- (iv) at the crossing points (8a, 8b) the rods (4, 6) are connected among each other; and
- (v) at the crossing points (8a, 8b) the rods (4, 6) of both series have a reduced thickness with respect to the basic thickness of the rod (4, 6) wherein the reduced thicknesses are represented by flattenings of the rods at the crossing points (8a, 8b) which each comprise a recess (10) and a flat portion (12) of the rod (4, 6) wherein the flat portion (12) is widened in the plane of the grid with respect to the cross section of the

basic rod and wherein the recesses (10) open in an alternating manner in opposite senses in the direction orthogonal to the grid plane.

- 2. Grid for structural reinforcement (2) according to claim 1 **characterized in that** the configuration of the two series of rods (4, 6) follows a plain weave.
- 3. Grid for structural reinforcement (2) according to claim 1 or 2 **characterized in that** the rods (4, 6) are selected among round bars, fibers or fiber bundles.
- 4. Grid for structural reinforcement (2) according to anyone of the preceding claims **characterized in that** said rods (4, 6) are consisting of composite material made of a fiber support and a resin matrix which joins the fibers of the support.
- 5. Grid for structural reinforcement (2) according to claim 4 **characterized in that** the rods at the crossing points (8a, 8b) are fixedly connected with a binding agent the basis of which is the same as of said resin matrix.
- 6. Grid for structural reinforcement (2) according to anyone of the preceding claims **characterized in that** the reduced thickness corresponds to the half of the basic thickness of the rod (4, 6).
- 7. Grid for structural reinforcement (2) according to anyone of the preceding claims **characterized in that** the rods (4, 6) essentially parallel among each other also have essentially the same distance between each other.
- 8. Reinforced building material comprising (i) a hydraulic binder, preferably selected among mortar, concrete, cement and other cementitious materials as a matrix, and (ii) a grid for structural reinforcement (2) according to anyone of the claims from 1 to 7 embedded in said matrix of hydraulic binder.
- 9. Use of the grid for structural reinforcement (2) according to anyone of the claims from 1 to 7 to stabilize asphalts or soil, in particular slanting grounds.

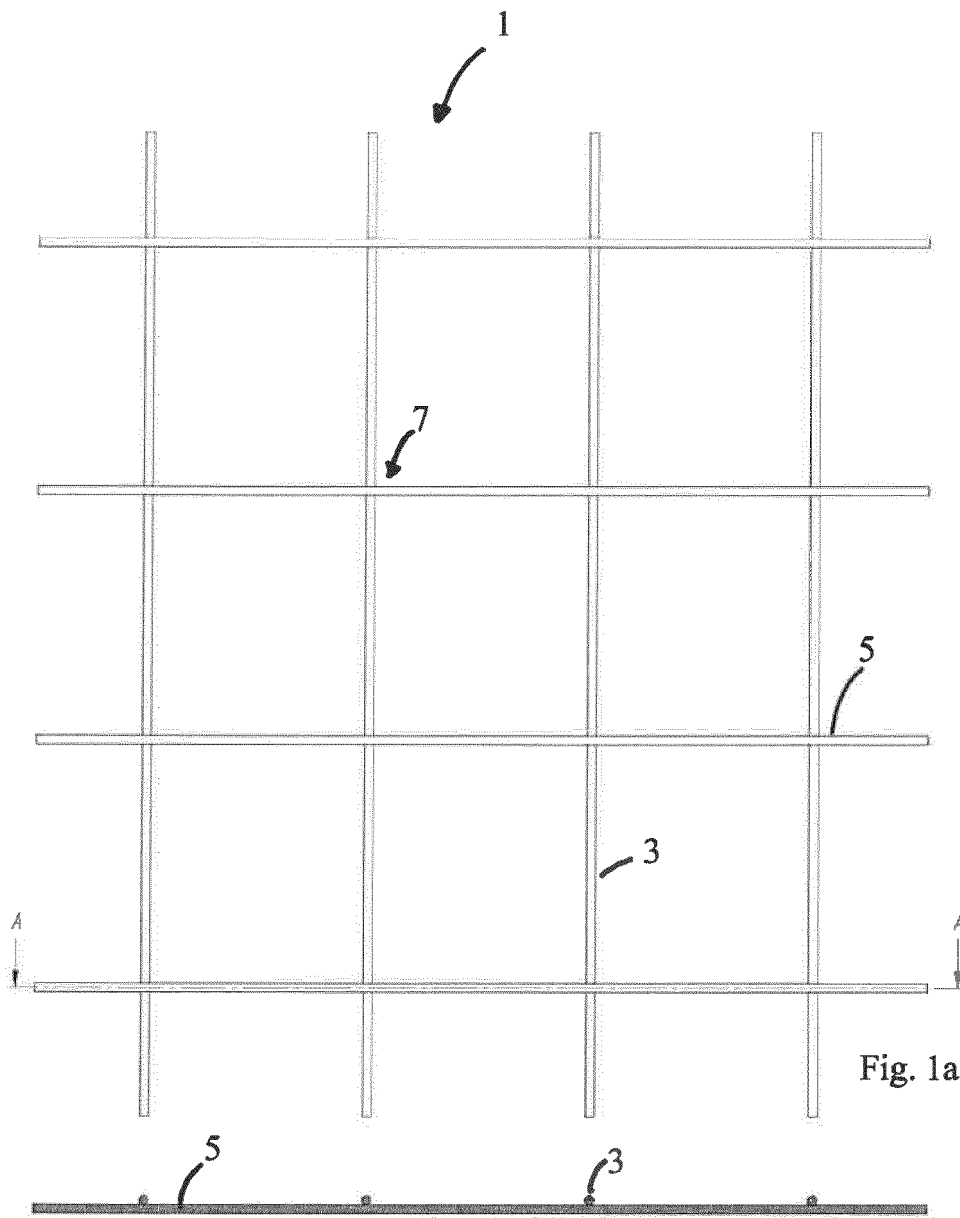


Fig. 1a

PRIOR ART

Fig. 1b

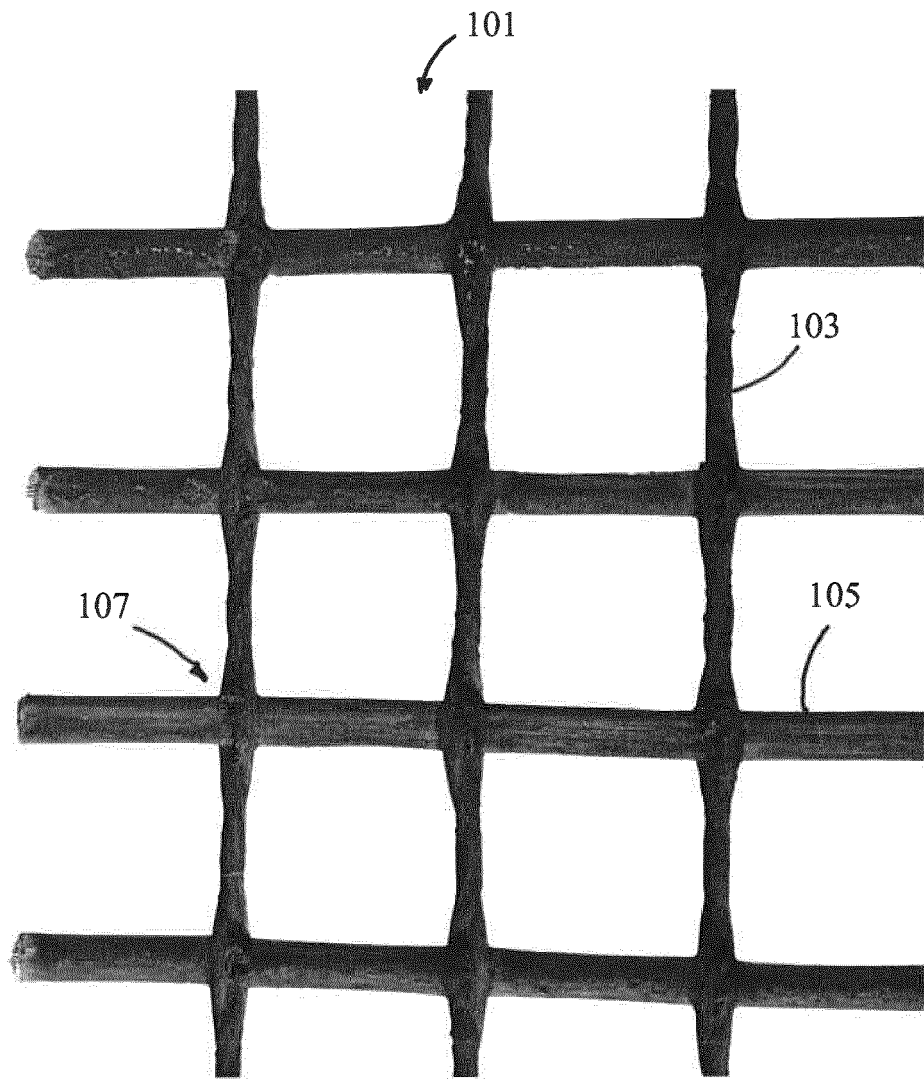


Fig. 2

PRIOR ART

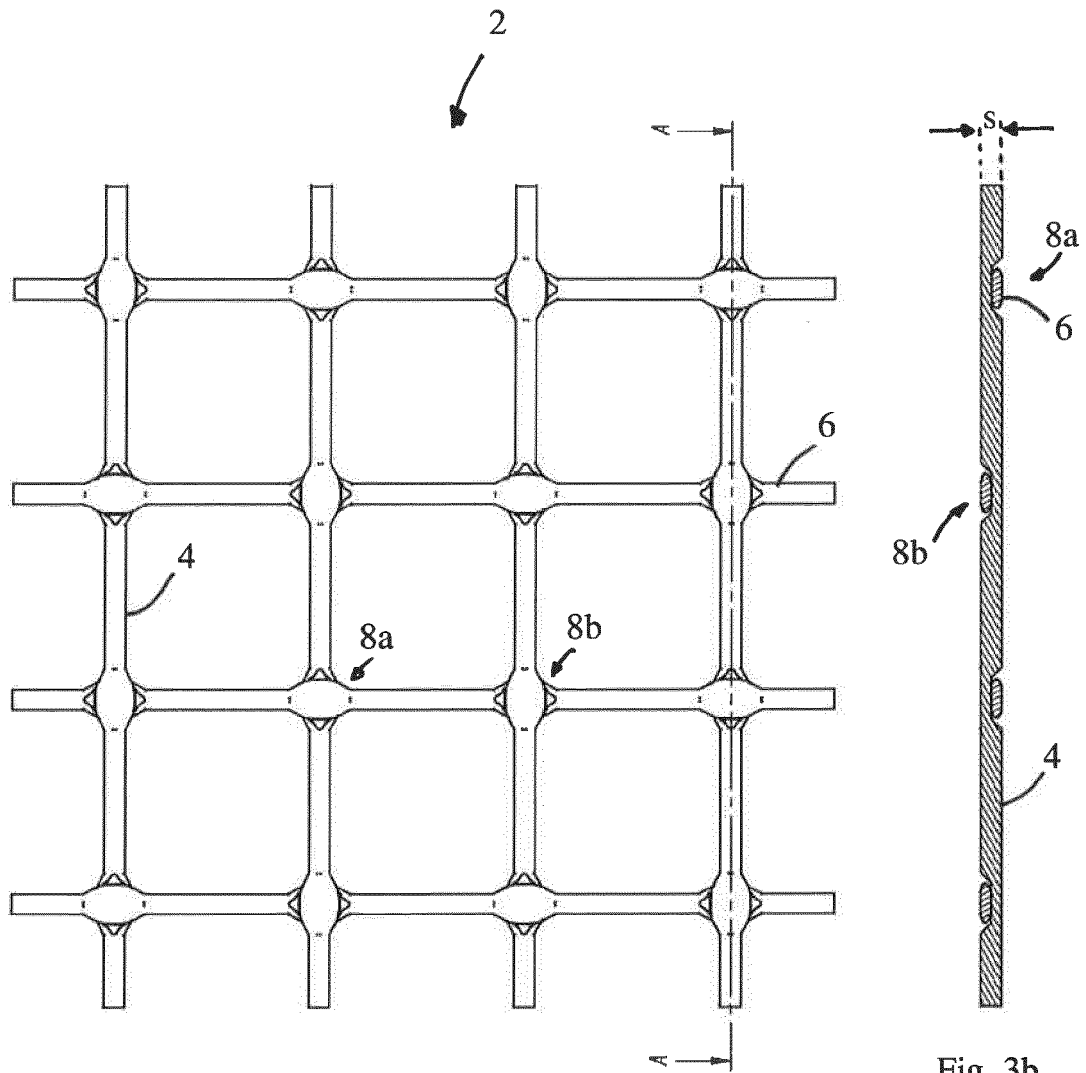


Fig. 3a

Fig. 3b

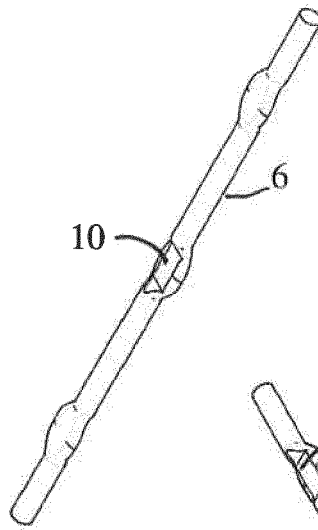


Fig. 4b

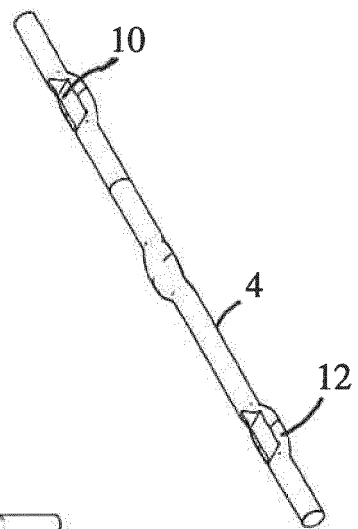


Fig. 4c

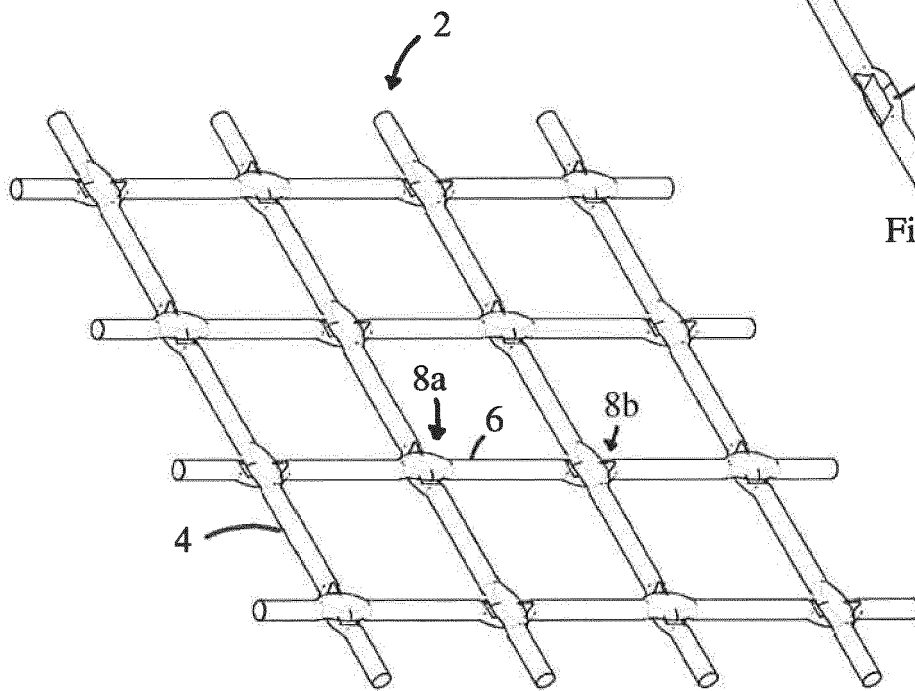


Fig. 4a

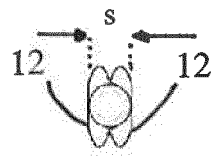


Fig. 5c

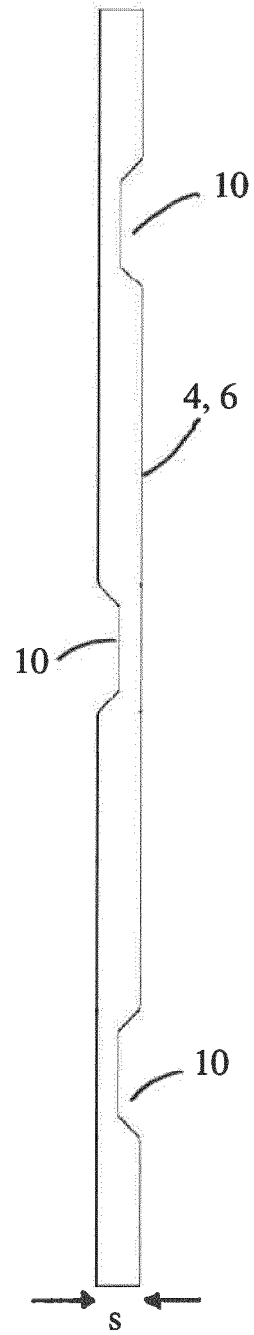


Fig. 5a

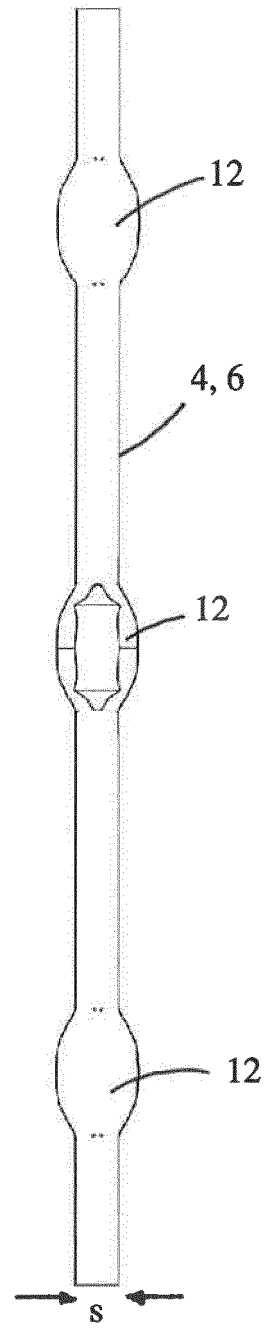


Fig. 5b



EUROPEAN SEARCH REPORT

 Application Number
 EP 18 18 2964

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 23 August 2018	Examiner Vratsanou, Violandi
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 18 18 2964

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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