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

(11) EP 4 273 344 A2

(12) # EUROPEAN PATENT APPLICATION

(43) Date of publication:
08.11.2023 Bulletin 2023/45

(21) Application number: **23192510.8**

(22) Date of filing: **03.11.2017**

(51) International Patent Classification (IPC):
E04C 5/18 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
E04C 5/0631; E04C 5/0604; E04C 5/064; E04C 5/18

(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 RS SE SI SK SM TR

(30) Priority: **03.11.2016 GB 201618561**

(62) Document number(s) of the earlier application(s) in accordance with Art. 76 EPC:
17793664.8 / 3 535 460

(71) Applicant: **Midland Steel Reinforcement Supplies Limited**
R32 NY77 Mountmellick Laois (IE)

(72) Inventors:
- **Woods, Martin Anthony**
  Coolbanagher, Emo, County Laois (IE)
- **Woods, Paul Robert**
  Coolbanagher, County Laois (IE)
- **Dolan, Kevin John**
  Coolbanagher, County Laois (IE)

(74) Representative: **Schütte, Gearoid Cruickshank**
8a Sandyford Business Centre
Sandyford
Dublin D18 R2N8 (IE)

Remarks:
This application was filed on 21.08.2023 as a divisional application to the application mentioned under INID code 62.

(54) **REINFORCING FRAMEWORK AND SLAB DESIGN**

(57) A method of fabricating and installing a reinforcing framework in the formation of reinforced concrete slabs in the construction of a building. The method includes prefabrication of the reinforcing framework in an off-site location; transporting and delivering a complete assembly of the fabricated reinforcing framework to the site; instalment of the reinforcing framework by lifting the complete assembly of the reinforcing framework into the desired position; and, applying concrete to the reinforcing framework.

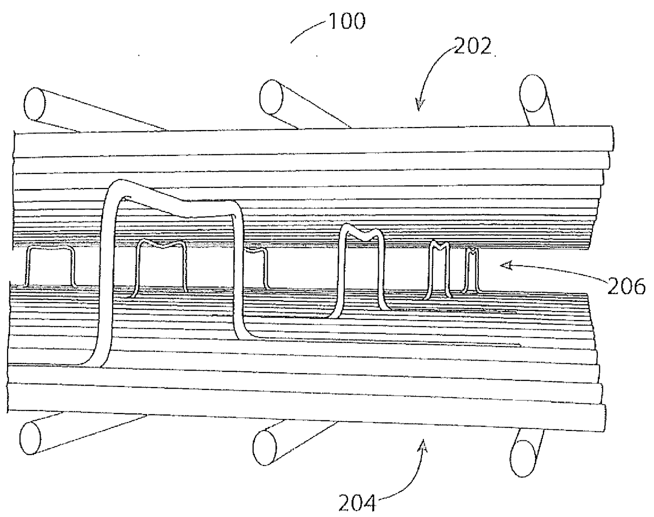

Figure 2

Processed by Luminess, 75001 PARIS (FR)

Description

Introduction

[0001] This invention relates to a reinforcing framework capable of prefabrication in an off-site location. The reinforcing framework can be subsequently transported to a building site location for instalment and use in the formation of reinforced concrete slabs in the construction of a building.

Background

[0002] Composite materials are widely used in the construction industry to form reinforced structures, for many reasons including durability, strength, tensile and thermal properties as well as flexibility in construction of various components and structures. It is to be appreciated that while concrete is an often used and popular choice for use in reinforced structures, other materials with similar physical properties, such as tensile strength and ductility, may be substituted.

[0003] Reinforcement of concrete or similar material is often achieved by embedding a skeletal framework formed of reinforcing materials made of steel, polymers, fibre glass, or alternate composite material into the concrete or similar material. Although commonly steel reinforcing bars (rebar) are used alone or in combination with other reinforcing materials.

[0004] Shear reinforcement is required to resist the effects of sheer or diagonal stress on a material, such as concrete. Thus shear links are often added to reinforcing frame work to counter shear stress.

[0005] The length of the reinforcing materials used in skeletal frameworks can be adjusted by splicing two reinforcing materials, such as rebar, together. Splicing allows for shear stress to be transferred from one rebar to another. Splicing can be achieved by lapping the bars, using a mechanical joint, or welding the bars together where they join or overlap. Preferably splicing of bars is performed on alternate bars with up to 50% of reinforcement bars spliced in any given section of a reinforcing structure.

[0006] Reinforced concrete is used to build many different types of structures and components of structures including, slabs, walls, floors, beams, columns, foundations and frames.

[0007] A small change in the design of a reinforced structure can have significant impact on material costs, construction schedule, and ultimate strength, as well as operating costs, occupancy levels and end use of a building.

[0008] Reinforced concrete can be classified as precast or cast-in-place concrete.

[0009] The typical approach to fixing a skeletal framework is for loose rebar, or other reinforcing material, to be delivered to the construction site and manually fixed in place using fixers in accordance with drawings to form the framework on which the end result reinforced structures are designed. This system has a number of drawbacks.

[0010] The loose rebar takes time to be loaded and unloaded from the vehicular transportation, meaning that there is increased disturbance at the offsite and onsite locations, as greater time is needed to complete the loading or offloading task. This issue is even more evident at onsite locations positioned on a busy road.

[0011] A substantial number of fixers require substantial crane time to complete the manual fixation of bars in place meaning that there is increased downtime in construction, particularly for other build projects that require a crane to complete.

[0012] For example a standard 1000 square foot reinforcing framework will require around 8 to 9 fixers and will take the 8 to 9 fixers about 5 to 6 working days to complete the reinforcing framework ready for concrete to be poured over the framework.

[0013] This approach is flawed as manual construction can be performed by construction personnel of varied competency and skill and is time consuming, taking anything from days to weeks to complete the fixing stage before the concrete is then poured over the framework.

[0014] Furthermore construction of a standard reinforcing framework is disruptive, diverting man hours and equipment away from other construction tasks and preventing other tasks and projects from getting started and/or from being completed.

[0015] Most building regulations and standards require that the reinforcing skeletal framework is checked and approved by a qualified engineer prior to the concrete being applied to the frame.

[0016] Manual construction of a skeletal framework, *in situ*, can lead to inconsistencies in approach with different interpretations of the design drawings being made. This can slow the construction and installation time as well as lead to errors in construction. Such errors may lead to a fail by the qualified engineer who may deem the reinforcing skeletal structure as not up to code and unsafe. A fail by the qualified engineer can delay construction with the skeletal framework needing to be redone before installation of the reinforcing structure can continue, with further checks required by the qualified engineer.

[0017] Delays incurred by inconsistent approaches can have serious cost implications on installation and overall construction.

[0018] The buildings and construction industry is under pressure to deliver faster, more cost-effective builds and build designs without compromising the quality, strength and durability of the end product.

[0019] There is a need, therefore, to provide alternative skeletal framework designs for reinforced structures that are capable of reducing build time, installation cost and improve durability and strength of the end product reinforced structure design.

[0020] Furthermore, single mesh layers are limited in the scope, complexity, and in particular, the size of reinforcing structures that can be created. It is an object of the present invention to provide alternative skeletal framework designs for reinforced structures that are capable of enabling larger reinforcing structures to be constructed.

Summary of the Invention

[0021] According to the invention, there is provided a reinforcing framework for the construction of reinforced concrete structures, including:

at least two mesh layers, namely, a first mesh layer and a second mesh layer,

a plurality of spaced-apart spacers mounted between the first layer and the second layer to support the two mesh layers spaced-apart in substantially parallel planes,

each spacer having a cross member with a leg extending outwardly at each end of the cross member, said legs being substantially parallel to each other and substantially perpendicular to the cross member,

each leg having a foot at an outer end of the leg remote from the cross member, the foot being substantially perpendicular to the leg and substantially perpendicular to the cross member, and

the cross member being bent inwardly between the legs.

[0022] In one embodiment of the invention the length of the cross member is sufficient to support a plurality of reinforcing bars.

[0023] In another embodiment of the invention, the spacing between the legs is greater than the spacing between adjacent parallel spaced-apart reinforcing bars of the mesh layer which engages the cross member.

[0024] In another embodiment, the cross member is curved inwardly between the legs.

[0025] In another embodiment, the cross member is V-shaped.

[0026] In a further embodiment, each spacer has feet which project outwardly from the legs in opposite directions.

[0027] In another embodiment a spacer is mounted at a lifting point for the reinforcing framework.

[0028] In another embodiment, a plurality of spaced-apart splice bars project outwardly at one or both sides of the frame. Preferably, the splice bars form an extension of one or both of the mesh layers. This arrangement facilitates automatic splicing of adjacent reinforcing frameworks during construction.

[0029] In another embodiment, there is provided a method of constructing and installing the reinforcing framework in the construction of reinforcing structures comprising the following steps:

(i) prefabrication of the reinforcing framework (100) in an off-site location;
(ii) transporting and delivering the complete assembly of the reinforcing framework (100) to the site of instalment;
(iii) instalment of the reinforcing framework (100) by lifting the complete assembly into position; and,
(iv) applying concrete to the reinforcing framework (100).

[0030] One advantage of the new reinforcing framework of the present invention is that reinforcing frameworks comprising elongate members with a diameter of 10mm or more can now be prefabricated in an offsite location.

[0031] Another advantage of the new reinforcing framework is that the design can be pre-approved by an engineer who has greater access for inspection.

[0032] A further advantage of the new reinforcing framework of the present invention is that is capable of being produced in a controlled factory environment with standardised equipment set up and standardised methods and approach to construction.

[0033] Another advantage of the new reinforcing framework is that build time onsite is greatly reduced with typical installation time taking minutes to hours to complete compared with the days to weeks' timeframe endured using traditional designs and manual assembly and installation techniques. Delivery and installation time is reduced by around 70% with no onsite labour required for fixing thereby increasing labour efficiency and decreasing labour costs associated with this task.

[0034] A further advantage of the new reinforcing framework of the present invention is that there are fewer disturbances to other onsite activities and to the surrounding area affected by the building project, as the fully assembled reinforcing framework of the present invention can be loaded and unloaded from the vehicular transportation swiftly.

[0035] A further advantage of the new reinforcing framework of the present invention is that monopoly of a crane for the purpose of assembling a reinforcing framework onsite by traditional fixing means is mitigated as the new reinforcing framework of the present invention arrives at the onsite location, fully assembled and ready to install and use.

[0036] A further advantage of the new reinforcing framework of the present invention is that monopoly of the crane for the purpose of loading and unloading the reinforcing framework and placing the reinforcing framework into the desired location for installation and use, is reduced.

[0037] A further advantage of the new reinforcing framework of the present invention is that the monopoly of skilled labour or manpower as traditionally required in assembling a reinforcing framework onsite by traditional fixing means, is mitigated as the new reinforcing framework of the present invention arrives at the onsite location, fully assembled and ready to install and use.

[0038] A further advantage of the new reinforcing framework of the present invention is that the health safety and wellbeing of onsite labour is improved.

[0039] A further advantage of the new reinforcing framework of the present invention is that productivity of the reinforcing framework made in factory environments is increased.

[0040] A further advantage of the new reinforcing framework is that it provides a standardised construction approach with improved accuracy and consistency in building the reinforcing framework on which the completed reinforcing structure such as, but not limited to, a slab design, is made.

[0041] A further advantage to the new reinforcing framework of the present invention is that by combining more than one mesh layer together, separated by a spacer, enables larger reinforcing structures to be constructed with rebar elements having diameters of up to 40mm.

[0042] In a further embodiment the cross member is curved such as to allow a gap to be formed between the cross member and the mesh layer engaged therewith.

[0043] In a preferred embodiment the gap formed between the cross member and the first mesh layer is generally positioned at a substantially midway point along the cross member and between proximal and distal ends of the cross member.

[0044] One advantage of the curve in the cross member is that the curve allows for ease of access through the gap positioned between the cross member and to the two sets of elongate members present in the first mesh layer such that it allows at least one bar to be placed between the two sets of elongate members present in the first mesh layer.

[0045] A further advantage of the curve in the cross member is that the curve allows for additional reinforcing bars to be added once the reinforcing framework has been fully assembled.

[0046] A further advantage of the curve in the cross member is that the curve allows for ease of access to enable the additional bars to be spliced together with the existing elongate members of the first mesh layer once the reinforcing framework has been fully assembled.

[0047] It is to be appreciated that the potential for post assembly modification of the fully assembled reinforcing framework allows for adjusting the strength of the overall framework ahead of transportation, installation and use. Said post assembly modification enables the design to be modified, if necessary, without needing to restart the assembly of the reinforcing framework completely from scratch.

[0048] It is to be appreciated that additional bars added to the reinforcing framework, post assembly or otherwise, said bar being intended to be spliced to existing elongate members in the first mesh layer, may alternatively be referred to as a "splice bar".

[0049] It is to be appreciated that any and all details pertaining to the second set of elongate members may also equally be applied to the first set of elongate members. Furthermore, any and all details pertaining to the first mesh layer may equally be applied to the second mesh layer. The mesh layers are interchangeable in this regard.

[0050] In a further embodiment the at least one bar may be placed evenly throughout the first mesh layer and adjacent to one or more elongate member.

[0051] In a preferred embodiment more than one bar is placed, namely a first bar and a second bar, such that the first bar is placed at a distance of approx. 500mm c\c from the second bar.

[0052] In a preferred embodiment the curve of the cross member is any angle from 1° to 45°.

[0053] In a more preferred embodiment the curve of the cross member is any angle from 5° to 30°.

[0054] In a most preferred embodiment the curve of the cross member is any angle from 8° to 15°.

[0055] A further advantage of the curve in the cross member is that splicing together the two sets of elongate members, present in the first mesh layer, where the first set of elongate members engage the second sets of elongate members, can be performed easily. Such positions, where the first set of elongate members engage the second set of elongate members, as spliced together may further be referred to as joints.

[0056] In a further embodiment the at least one contact point is substantially adjacent to the distal or proximal ends of the cross member.

[0057] In a preferred embodiment the cross member comprises at least two contact points.

[0058] One advantage of the contact points is that the contact points provides clearly defined positions on the first mesh layer that provide improved purchase, such that the fully assembled reinforcing framework may be lifted about the contact points from the vehicular transportation to the desired position for final instalment and use. Such contact points may also be referred to as lifting points.

[0059] It is to be appreciated that "purchase" as used in context of the lifting points covers obtaining a firm contact, hold, grasp, attachment or grip on the object to be lifted, such as the fully assembled reinforcing framework, or to haul up the desired item to be moved, such as the fully assembled reinforcing framework, by means of a pulley or lever system and any vehicular or apparatus comprising a pulley and lever system, such as a crane.

[0060] A further advantage of the contact points is that the contact points enable multiple fully assembled reinforcing frameworks to be lifted from the vehicular transportation to the desired position for instalment and use. Being able to lift multiple fully assembled reinforcing frameworks in a single lift means that the time taken to load and unload the reinforcing framework is greatly reduced and less disturbance of other onsite activities.

[0061] A further advantage of the contact points is that, due to the reduced number of lifts required to load or unload the fully assembled reinforcing frameworks, the crane time needed is significantly reduced freeing up the crane for other onsite jobs or projects. This has a positive impact on overall build time meaning that the construction project can be completed in a shorter time period.

[0062] One advantage of having each foot portion extending in the opposite direction to one another is that stability of the overall spacer is improved.

[0063] In another embodiment the cross member, the leg portion and the foot portion are all mutually orthogonal.

[0064] In one embodiment each of the first mesh layer and second mesh layer comprise at least two sets of elongated members, namely a first set and a second set.

[0065] One advantage of the present invention is that the diameters of the elongate members, used in constructing the mesh layers, namely the first mesh layer and the second mesh layer, can range from 10mm to 100mm.

[0066] Preferably, the diameters of the elongate members, used in constructing the mesh layers, namely the first mesh layer and the second mesh layer, range between 10mm to 70mm.

[0067] More preferably, the diameters of the elongate members, used in constructing the mesh layers, namely the first mesh layer and the second mesh layer, range between 10mm to 50mm.

[0068] Most preferably, the diameters of the elongate members, used in constructing the mesh layers, namely the first mesh layer and the second mesh layer, range between 10mm to 40mm.

[0069] In a further embodiment the first set of elongated members and the second set of elongate members are positioned substantially perpendicular to one another.

[0070] In a further embodiment the first set of elongate members are arranged in pairs, each pair of elongate members being positioned substantially in parallel to the next pair of elongate members.

[0071] In a preferred embodiment in each pair of elongate members each elongate member differs in length.

[0072] One advantage to having differing lengths of elongate members is that it allows for greater flexibility in the design of different types of reinforcing structures.

[0073] A further advantage to having differing lengths of elongate members is that it allows for designs to be adjusted to fit onsite dimensions.

[0074] In a most preferred embodiment in each pair of elongate members one elongate member is substantially shorter than the other elongate member that makes up the pair.

[0075] In a further embodiment at least a proportion of the individual components that make up the reinforcing framework are made from one or more of steel, rebar, polymers, fibre glass and alternate composite material or any combination thereof.

[0076] The present invention is further directed towards a method of fabricating and installing the reinforcing framework in the construction of reinforcing structures comprising prefabrication of the reinforcing framework in an off-site location; transporting and delivering a complete assembly of the fabricated reinforcing framework to the site; instalment of the reinforcing framework by lifting the complete assembly into the desired position; and, applying concrete to the reinforcing framework.

[0077] One advantage of the method of fabricating and installing reinforcing framework of the present invention is that production in a controlled factory environment with standardised equipment set up and standardised methods and approach to construction enables a fast and efficient turnaround of production of individual components and the fully assembled reinforcing structure.

[0078] It is to be appreciated that the method of fabricating and installing reinforcing framework with standardised equipment set up can speed up production of the fully assembled reinforcing structure by being continually present and in the desired position ready for assembly purposes. It is to be appreciated that during onsite fabrication of similar reinforcing frameworks the equipment is often moved and repositioned for the purpose of other onsite jobs, meaning that the fabrication is slowed as the equipment needs to be returned to the desired position for the purpose of fabricating reinforcing frameworks.

[0079] A further advantage of the method of fabricating and installing reinforcing framework of the present invention is that mass production is enabled.

[0080] It is to be appreciated that the reinforcing framework of the present invention, fully assembled or otherwise, may be transportable at any length and width, and in particular any wide-load width or parameters as may be required or imposed by vehicular transportation.

[0081] In a further embodiment the method comprises a drying step following the application of concrete, in particular when the concrete is cast-in-place.

[0082] The advantage of having a drying step is to set the concrete, or other similar material, hard and in place against the reinforcing framework to form a strong and robust reinforcing structure.

[0083] In a further embodiment the reinforcing frameworks of the present invention are for use in the construction of one or more reinforcing structures including, but not limited to, slabs, walls, floors, beams, columns, foundations and frames.

[0084] It is to be appreciated that the fully formed reinforcing framework, for use in constructing reinforcing structures, can be arranged in a variety of sequences in conjunction with other reinforcing frameworks including, but not limited to, in series and in parallel.

Brief Description of the Drawings

[0085] The invention will be more clearly understood from the following description of some embodiments thereof, given by way of example only, with reference to the accompanying drawings, in which:

Figure 1 shows a perspective view of a portion of a reinforcing framework in accordance with the present invention;

Figure 2 shows a front view of the reinforcing framework of Figure 1;

Figure 3 shows a side sectional view of the reinforcing framework of Figure 1;

Figure 4 shows a further side sectional view of the reinforcing framework of Figure 1;

Figures 5a to 5g show a series of fabrication steps for constructing the reinforcing framework of Figure 1 and a resulting reinforcing structure;

Figure 6 is a plan view of another reinforcing framework according to another embodiment of the invention;

Figure 7 is a side sectional elevational view showing the reinforcing framework of Figure 6 in use;

Figure 8 is a plan view of a further reinforcing framework according to another embodiment of the invention;

Figure 9 is a side sectional elevational view of the reinforcing framework of Figure 8, shown in use;

Figure 10 is a detail perspective view showing the reinforcing framework of the invention in use;

Figure 11 is another detail perspective view showing the reinforcing framework in use;

Figure 12 is a perspective view showing a reinforcing framework of the invention in use; and

Figure 13 is a detail perspective view showing portion of the arrangement in Fig. 12.

Detailed Description of the Preferred Embodiments

[0086] Referring to the drawings and initially to Figure 1, there is provided a prefabricated reinforcing skeletal framework according to the invention, indicated generally by reference numeral 100 for use in the construction of reinforced structures such as floor slabs and wall slabs in buildings. The reinforcing skeletal framework 100 is shown without a set of elongate members of a first top mesh layer, in order to improve the understandability of the drawing.

[0087] Referring to Figures 2 and 3 the reinforcing skeletal framework comprises at least two mesh layers, namely a first mesh layer and a second mesh layer, indicated generally by reference numerals 202 and 204 respectively; and, a plurality of spacers, generally indicated by reference numeral 206.

[0088] The first mesh layer 202 and the second mesh layer 204 are substantially adjacent from one another and, when fully constructed for use, are held separate by the plurality of spacers 206. A plurality of spaced-part spacers 206 support the two mesh layers spaced-apart in substantially parallel planes in a double skin construction. Each of the plurality of spacers 206 is formed of a cross member 302, leg portions 304 and foot portions 306.

[0089] Each leg portion 304 has a top and a bottom and is connected, at the top of the leg portion 304, to a distal or proximal end of the cross member 302. The leg portion 304 is positioned substantially perpendicular to the cross member 302. Each leg portion 304 is also connected to at least one foot portion 306 at the bottom end of the leg portion 304 remote from the cross member 302. The foot portion 306 extends substantially perpendicular to the leg portion 304. In this way, the cross member 302, the leg portion 304 and the foot portion 306 may be mutually orthogonal to each other.

[0090] Preferably the foot portions 306 project outwardly from the legs 304 in opposite directions as shown in the drawings.

[0091] Referring in particular to Figure 3, the first mesh layer 202 and second mesh layer 204 independently comprise of at least two sets of elongated reinforcing bar members, namely a transverse first set 308 and a longitudinal second set 310 of spaced-apart reinforcing bars in parallel alignment, positioned substantially perpendicular to one another, so as to form a grid-like structure for the mesh layer 202, 204. The second set of elongate members 310 is arranged in pairs 312 of reinforcing bars, comprising a first elongate reinforcing bar member 312a and a second elongate reinforcing bar member 312b, each pair of elongate members 312 being positioned substantially parallel to and spaced-apart from the next pair of elongate members 312 within the second set of elongate members 310.

[0092] Within each of the pairs of elongate members 312 present in the second set of elongate members 310, the first elongate member 312a making up each pair of elongate members 312 may independently be of different length to the second elongate member 312b making up each pair of elongate members 312. In particular the second elongate member 312b which forms one of the pair of elongate members 312 may be substantially shorter than the first elongate member 312a that forms the other of the pair of elongate members 312.

[0093] Each of the pairs of elongate members 312 may be of different lengths independently of each other pair in the second set of elongate members 310.

[0094] It is to be appreciated that any and all details pertaining to the second set of elongate members 310 may also equally be applied to the first set of elongate members 308. Furthermore, any and all details pertaining to the first mesh layer 202 may equally be applied to the second mesh layer 204. The mesh layers 202, 204 are interchangeable in this regard.

[0095] Referring in particular to Figure 4, the cross member 302 has a distal and proximal end, with a portion of the cross member 302 curved intermediate the ends such as to allow at least one contact point 402 between the cross member 302 and the first mesh layer 202, wherein the contact point 402 is located towards one of the distal and proximal ends of the cross member 302. Said portion of the cross member 302 being curved intermediate the ends also allows for a gap 404 to be formed between the cross member 302 of the spacer 206 and the first mesh layer 202.

[0096] An example of a fabrication method of the reinforcing framework of the present invention will now be described. It will be appreciated that alternative methods of fabrication may be used.

[0097] Referring to Figure 5a the reinforcing framework 100 is fabricated firstly by laying out the first set of elongate members 308, spaced-apart and substantially in parallel to one another. This is followed by the second elongate members 312b of the second set of elongate members 310 positioned spaced-apart and mutually orthogonal to the first set of elongate members 308 as shown in Figure 5b.

[0098] In Figure 5c, it can be seen that the spacers 206 are positioned substantially adjacent to and resting on the first set of elongate members 308, such that the foot portions 306 of the spacer 206 are positioned substantially adjacent to the second elongate member 312b of the second set of elongate members 310. The foot portions 306 of the spacer 206 are then secured to the second elongate member 312b of the second set of elongate members 310 and the second elongate members 312b are secured to the elongate members 308.

[0099] As is shown in Figure 5d, the first elongate member 312a is positioned substantially adjacent to the second elongate member 312b to form a pair of elongate members 312 within the second set of elongate members 310. The first elongate member 312a is then secured to the second elongate member 312b to complete the second mesh layer 204.

[0100] It is to be appreciated that alternatively to that shown in Figure 5d the first elongate member 312a may be positioned substantially adjacent to the foot portions 306 of the spacer 206, such that the foot portions 306 of the spacer 206 are positioned between the first elongate member 312a and the second elongate member 312b.

[0101] As is further seen from Figure 5d some further second elongate members 312b are arranged substantially in parallel and over the cross members 302 of the plurality of spacers 206.

[0102] Further first elongate members 312a are laid out substantially adjacent to the further second elongate members 312b so as to be substantially adjacent the cross member 302 of the spacer 206 as can be seen in Figure 5e. The first elongate members 312a and second elongate members 312b are secured together to form a pair of elongate members 312 and forming a further second set of elongate members 310.

[0103] As can be seen in Figure 5f, a further first set of elongate members 308 are positioned mutually orthogonal to the further second set of elongate members 310. The further first set of elongate members 308 and the further second set of elongate members 310 are secured together to form the first mesh layer 202. The first mesh layer 202 is then secured to the cross member 302 of the spacers 206. The prefabricated mesh cage construction thus formed can be transported to a building site and lifted into position.

[0104] With particular reference to Figure 5g construction of the reinforcing structure comprising the reinforcing framework 100 is completed *in situ* at an onsite location; concrete, or other material, is applied to the reinforcing framework 100, such that only a portion of the first mesh layer 202 and the second mesh layer 204 remain visible, namely the ends of the pair of elongate members 312 that make up the second set of elongate members 310 present in both the first mesh layer 202 and the second mesh layer 204.

[0105] It is to be appreciated that while Figures 5a to 5g show the method for fabrication of the reinforcing framework 100 of the present invention as following a certain series of steps as outlined above, the method of fabrication may comprise similar steps conducted in alternative orders, such as may be considered more efficient or otherwise beneficial, without being considered to substantially deviate from the present invention.

[0106] Furthermore, it is to be appreciated that while Figures 5a to 5g show the first mesh layer 202 and second mesh layer 204 to be constructed *in situ* in connection with the spacer 206, that each of the mesh layers, namely the first mesh layer 202 and the second mesh layer 204 may be fabricated independently and separately from each other and the reinforcing framework 100. The complete assembly of the first mesh layer 202 and the complete assembly of the second mesh layer 204 are then incorporated into the fabrication of the reinforcing framework 100 of the present invention. Such method of fabricating the reinforcing framework 100 of the present invention may comprise firstly laying out the second mesh layer 204 before placing the spacers 206 positioned substantially adjacent to the first set of elongate members 308, such that the foot portions 306 are positioned substantially adjacent to the second elongate member 312b of the second set of elongate members 310 present in the second mesh layer 204. The foot portions 306 of the spacer 206 are then secured to the second elongate member 312b of the second set of elongate members 310 present in the second mesh layer 204; The first mesh layer 202 is placed such as to position the first mesh layer 202 substantially adjacent to the cross member 302 of the spacer 206. The first mesh layer 202 is placed, such that shear links contained within the first mesh layer 202 are positioned substantially adjacent to the lifting points. The first set of elongate members 308 are then spliced to the second set of elongate members 310, where the first set of elongate members 308 and the second set of elongate members 310 fall within the curve area of the cross member 302 of the spacer 206. The first mesh layer 202 is then secured to the cross member 302 of the spacer 206 about the contact points.

[0107] It is to be appreciated that securing of elongate members and the spacer may include, but is not limited to, splicing and fixers made of steel or other material as may be deemed appropriate in the industry for use as a fixer, and welding. Splicing may include, but is not limited to, half lap splice, bevel lap splice and tabled splice joints as may be deemed appropriate. Welding may include any form of welding technique, as may be deemed appropriate, including, but not limited to spot welding, bottom welding,

[0108] **Example 1:** Method of constructing and installing a reinforcing framework for a slab design in accordance with the present invention.

[0109] The reinforcing framework 100 is firstly designed and approved by engineers. Prefabrication in an offsite location is achieved by fixing the components of the reinforcing framework 100 using standard steel fixers according to a slab format design, as pre-approved by an engineer. The assembled reinforcing framework 100 is then transported and delivered, in one piece, to the site of instalment. Instalment involves lifting the assembled reinforcing framework 100, in one piece, into the desired position and cast-in-place concrete applied to the reinforcing framework 100. The concrete is then allowed to dry before use of the fully formed slab.

[0110] Referring now to Fig. 6 and Fig. 7, there is shown another reinforcing framework according to the invention, indicated generally by the reference numeral 400. Parts similar to those described previously are assigned the same reference numerals. In this case, splice bars 401 project outwardly at one side of the reinforcing framework 400 in a single fly arrangement. Fig. 7 shows a concrete slab 402 cast about the reinforcing framework 400 in use.

[0111] Referring now to Fig. 8 and Fig. 9, there is shown another reinforcing framework according to another embodiment of the invention, indicated generally by the reference numeral 500. Parts similar to those described previously are assigned the same reference numerals. In this case, sets of splice bars 401 project outwardly at both sides of the reinforcing framework 500. It will be noted that this has a double fly construction with the splice bars 401 projecting out at opposite sides of the reinforcing framework 500 and forming an extension of the first mesh layer 202 and second mesh layer 204.

[0112] The arrangements in Figures 6 to 9 advantageously provide for automatic splicing of the reinforcing frameworks 400, 500 during construction of a building. The reinforcing framework 400 is inserted first. Then a required number of the reinforcing framework 500 are dropped into place in alignment with the first reinforcing framework 400 with the splice bars 401 overlapping with the adjacent framework. It will be appreciated that the reinforcing frameworks 400, 500 facilitate automatic splicing of the reinforcing frameworks 400, 500 which greatly speeds up the construction process.

[0113] Referring now to Fig. 10, this shows the knitting together of a vertical wall panel 600 and a reinforcing framework 400. Fig. 11 shows this from another angle. It will be noted that U-bar ends 410 on the reinforcing framework 400 accommodate varying dimensions. It will be appreciated that the wall panel reinforcement may be formed by any of the reinforcing frameworks of the invention previously described.

[0114] Referring in particular to Fig. 12 and Fig. 13, this shows a reinforcing framework 500 mounted at a column 700. It will be noted in Fig. 13, a cutaway portion 502 is provided in the reinforcing framework 500 to accommodate the column 700. Shear links 503 are incorporated into the steelwork of the reinforcing frame 500 around the opening 502.

[0115] It is to be appreciated that while the present example demonstrates a slab design the reinforcing framework may also be used to construct and install other reinforcing structures such as, but not limited to, walls, floors, beams, columns, foundations and frames.

[0116] It is also to be appreciated that while the example provided uses concrete other materials with similar physical properties may be readily substituted.

[0117] It is also to be appreciated that while the example provided describes the cast-in-place concrete applied to the reinforcing framework after transport and delivery to the onsite location, the concrete may be applied to the reinforcing framework before the fully assembled reinforcing framework is transported and delivered to the onsite location.

[0118] Furthermore where precast concrete is used a drying step is not necessary.

[0119] The terms "comprise" and "include", and any variations thereof required for grammatical reasons, are to be considered as interchangeable and accorded the widest possible interpretation.

[0120] The terms "framework", "skeletal framework", "frame" and "skeleton" refer to a structure, or structures, for supporting or enclosing a reinforcing structure or prefabricated concrete, such as reinforcing slab designs, and as such are to be considered as interchangeable and accorded the widest possible interpretation. Said terms should not be confused with "formwork" or "shuttering" as further defined below.

[0121] The terms "formwork" or "shuttering, refer to temporary or permanent moulds into which cement, or other material, may be poured and allowed to dry, and as such may be formed of "framework", "skeletal framework", "frame" and "skeleton".

[0122] The terms "contact points" and lifting points" are to be considered as interchangeable and accorded the widest possible interpretation.

[0123] The terms "clc" and "O.C" are commonly used term in construction to mean centre to centre and on centre respectively and as such are to be considered as interchangeable and accorded the widest possible interpretation.

[0124] The terms "double skin" and "double skin mats" are well known industry terms to mean a set of skins, panels or rebar mats or mesh layers and as such are to be considered as interchangeable and accorded the widest possible interpretation.

[0125] It will be understood that the components referred to a standard steel fixers throughout may be readily substituted for other standard fixers that may be applicable for use in the prefabrication and construction of reinforcing frameworks, reinforcing structures, reinforcing slab designs and other reinforcing structures.

[0126] It will be understood that the components shown in any of the drawings are not necessarily drawn to scale, and, like parts shown in several drawings are designated the same reference numerals.

[0127] It will be further understood that features from any of the embodiments may be combined with alternative described embodiments, even if such a combination is not explicitly recited hereinbefore but would be understood to be technically feasible by the person skilled in the art.

[0128] The invention is not limited to the embodiments hereinbefore described which may be varied in both construction and detail within the scope of the appended claims.

Claims

1. A method for the formation of a reinforced concrete slab in the construction of a building at a construction site, the method comprising the steps:

(i) prefabricating a reinforcing framework (100) in an off-site location;
(ii) transporting and delivering the completed assembly of the reinforcing framework (100) to the site of instalment;
(iii) installing the reinforcing framework (100) on site by lifting the complete reinforcing framework (100) assembly into position; and,
(iv) applying concrete to the reinforcing framework (100).

2. The method as claimed in claim 1, wherein the reinforcing framework (100) comprises:

at least two mesh layers (202, 204), namely, a first mesh layer (202) and a second mesh layer (204),
a plurality of spaced-apart spacers (206) mounted between the first layer (202) and the second layer (204) to support the two mesh layers (202, 204) spaced-apart in substantially parallel planes,
each spacer (206) having a cross member (302) with a leg (304) extending outwardly at each end of the cross member (302), said legs (304) being substantially parallel to each other and substantially perpendicular to the cross member (302), each leg (304) having a foot (306) at an outer end of the leg (304) remote from the cross member (302), the foot (306) being substantially perpendicular to the leg (304) and substantially perpendicular to the cross member (302), and
the cross member (302) being bent inwardly between the legs (304).

3. The method as claimed in claim 2 wherein the length of the cross member is sufficient to support a plurality of reinforcing bars.

4. The method as claimed in claim 2 or claim 3, wherein the spacing between the legs is greater than the spacing between adjacent parallel spaced-apart reinforcing bars of the mesh layer which engages the cross member.

5. The method as claimed in any one of claims 2 to 4, wherein the cross member is curved inwardly between the legs.

6. The method as claimed in any one of claims 2 to 4, wherein the cross member is V-shaped.

7. The method as claimed in any one of claims 2 to 6, wherein each spacer has feet which project outwardly from the legs in opposite directions.

8. A method as claimed in any one of claims 2 to 7 wherein a spacer is mounted at a lifting point for the reinforcing framework.

9. The method as claimed in any one of claims 2 to 8, wherein a plurality of spaced-apart splice bars project outwardly at one or both sides of the frame.

10. The method as claimed in claim 9, wherein the splice bars form an extension of one or both of the mesh layers.

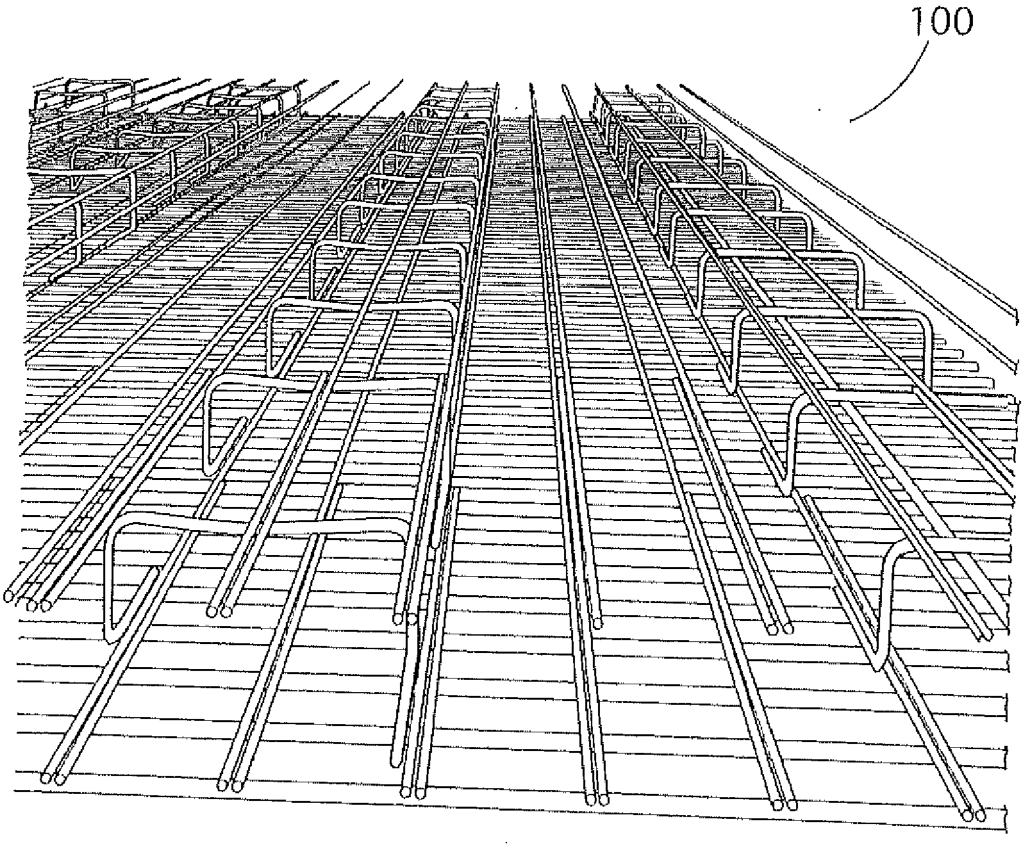

Figure 1

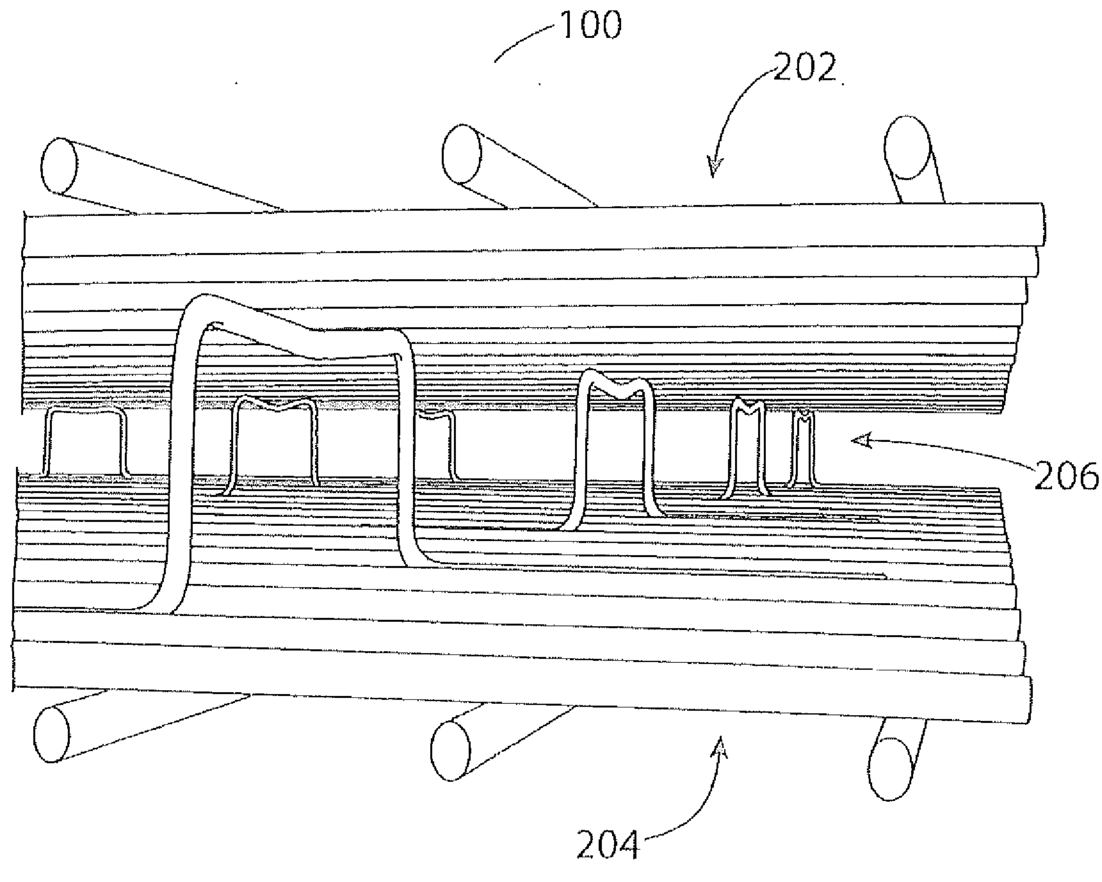

Figure 2

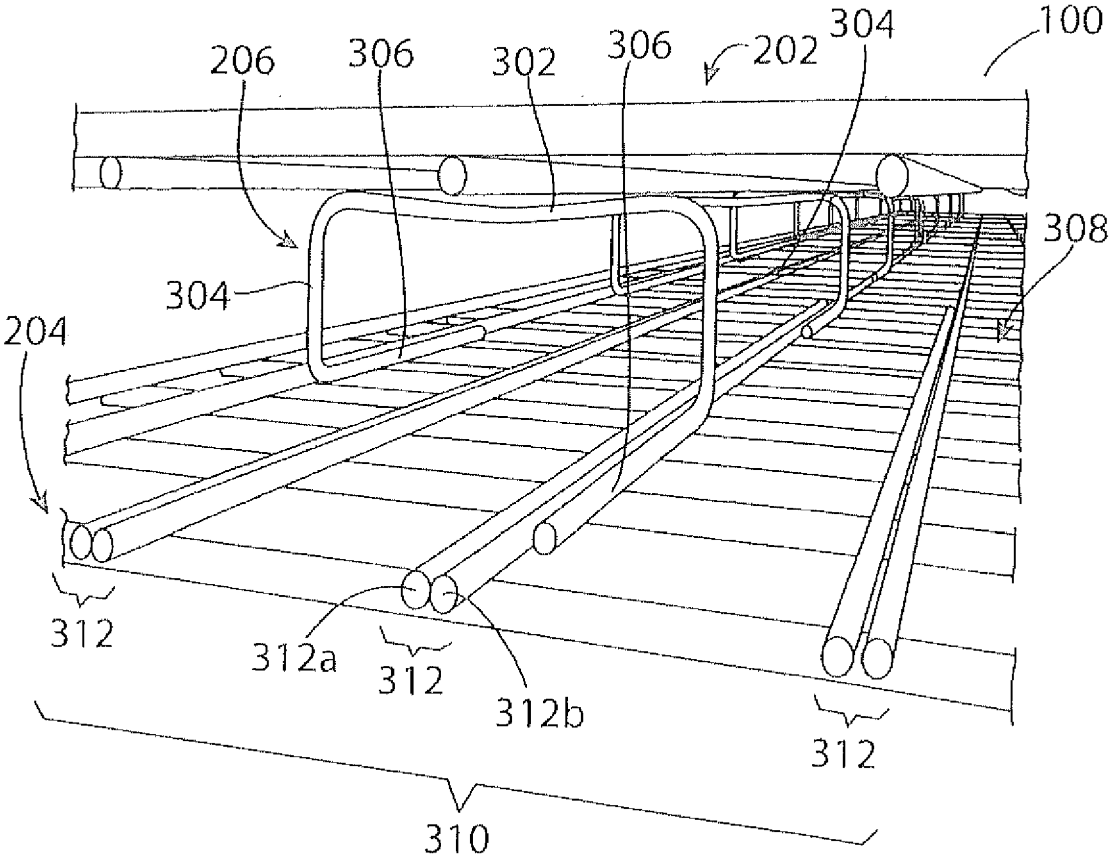
206
306
302
306
202
304
100
308
304
204
312
312a
312
312b
312
310

Figure 3

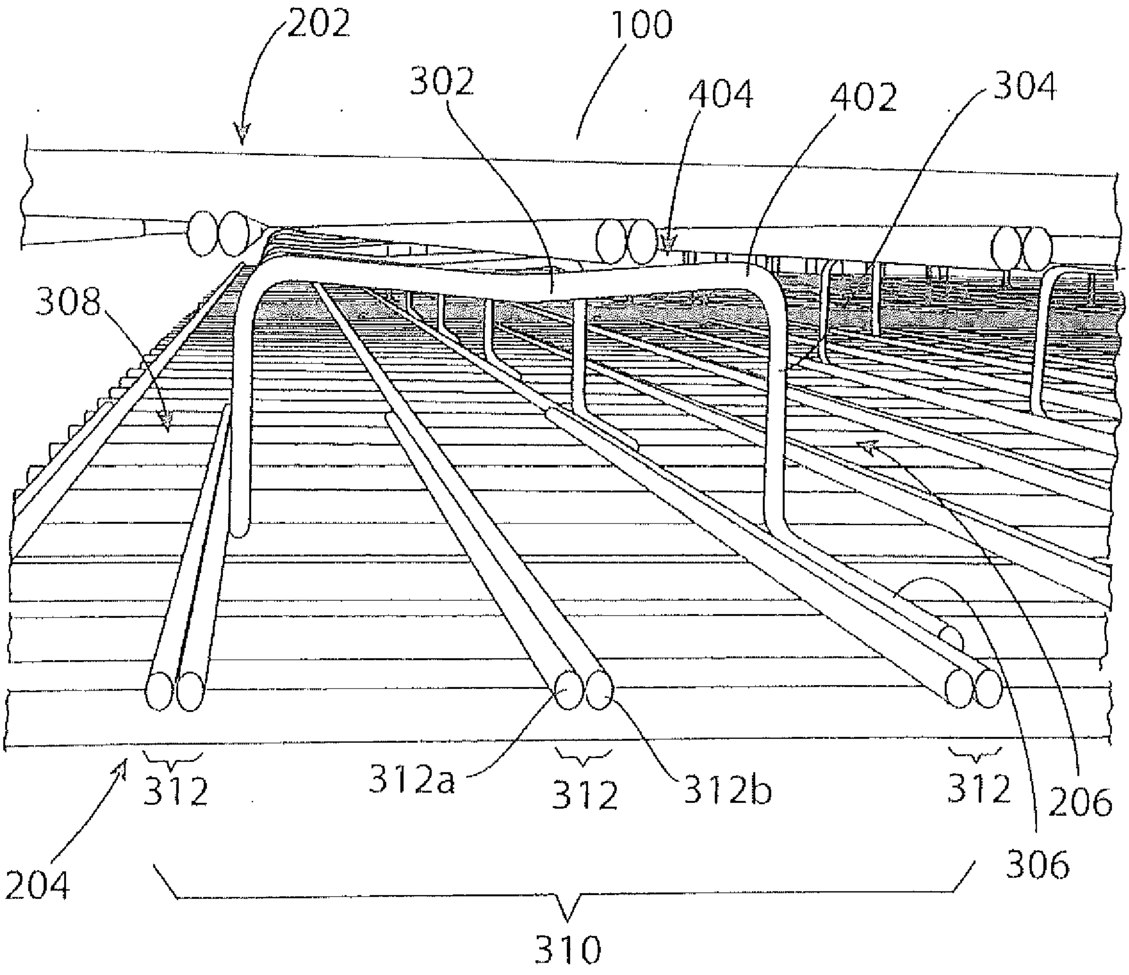
202
100
302
404
402
304
308
312
312a
312
312b
312
206
306
204
310

Figure 4

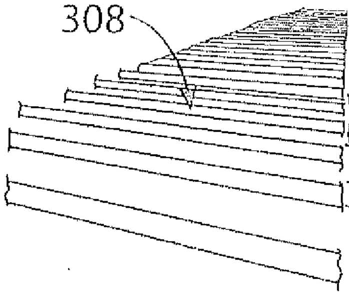

Figure 5a

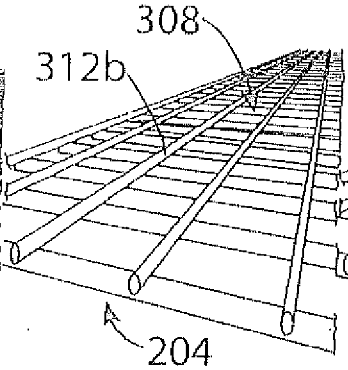

Figure 5b

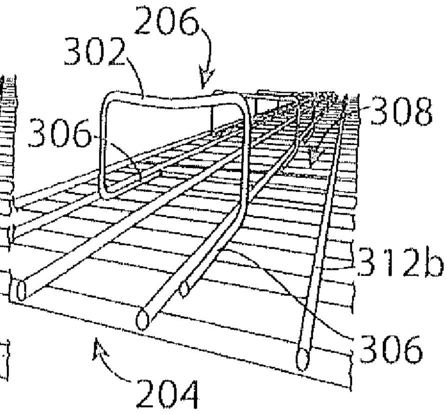

Figure 5c

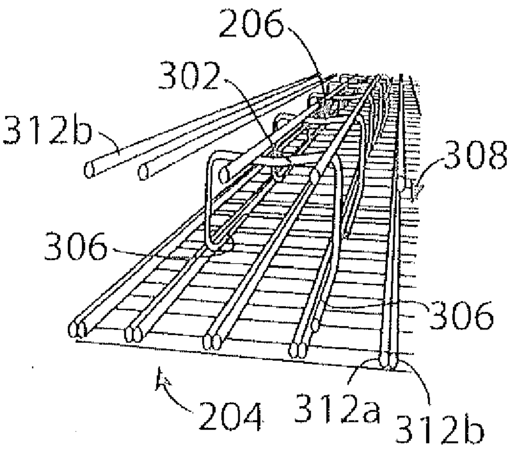

Figure 5d

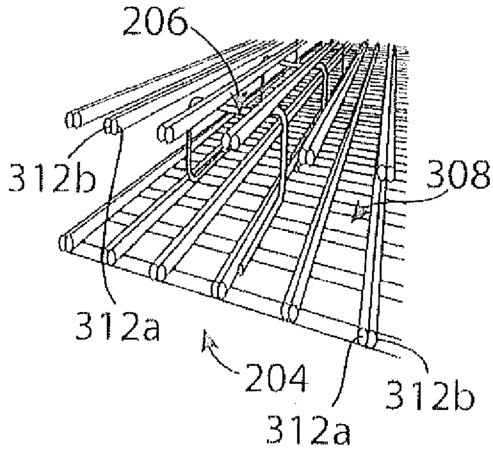

Figure 5e

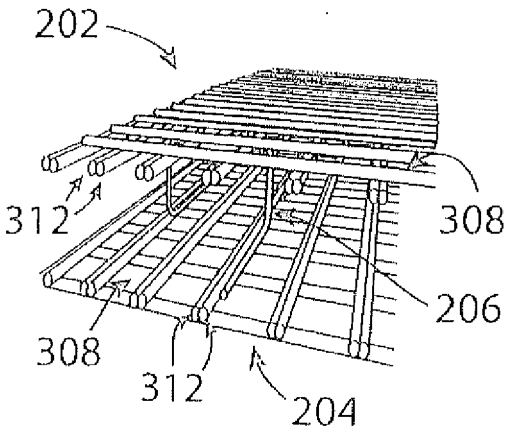

Figure 5f

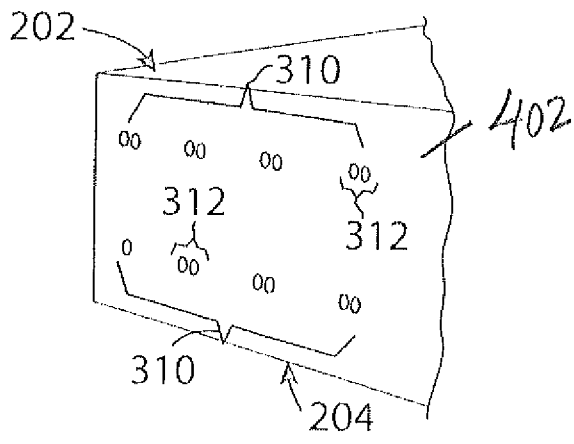

Figure 5g

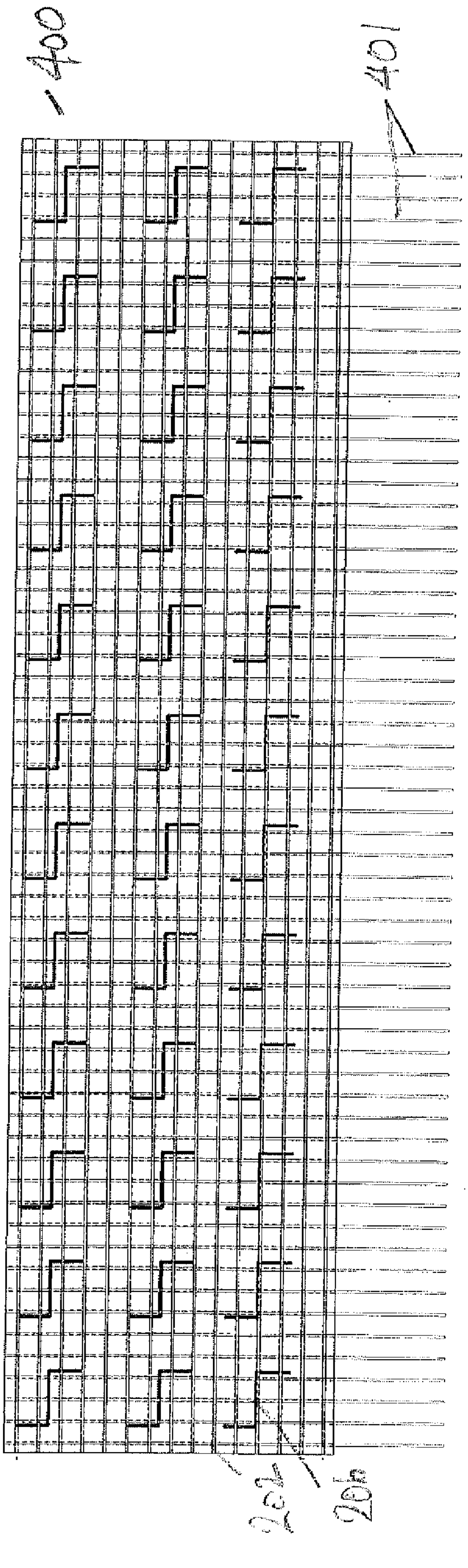

FIG6

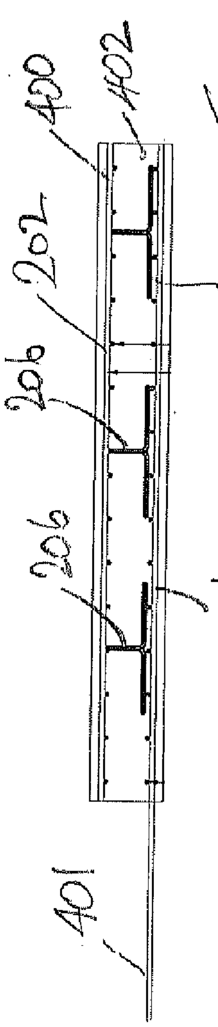

FIG.7

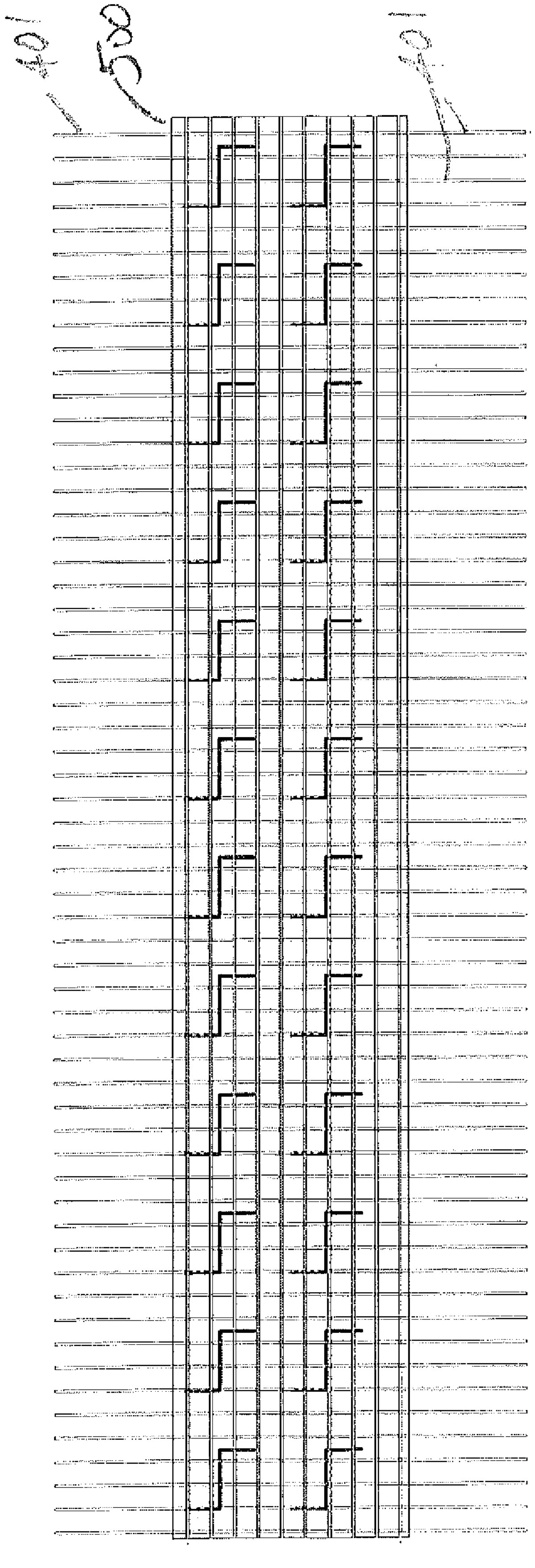

FIG 8

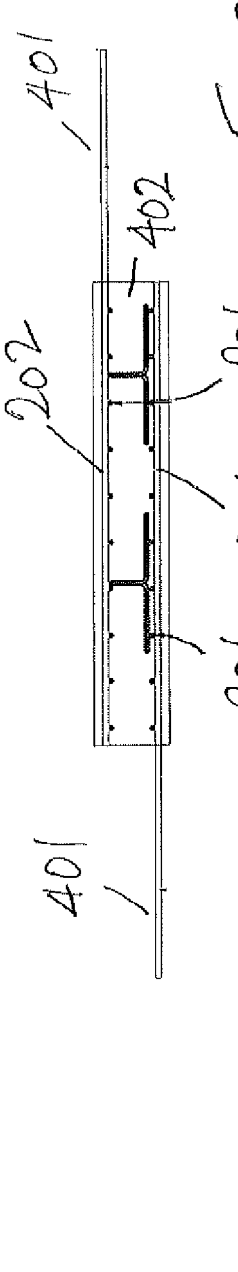

FIG 9

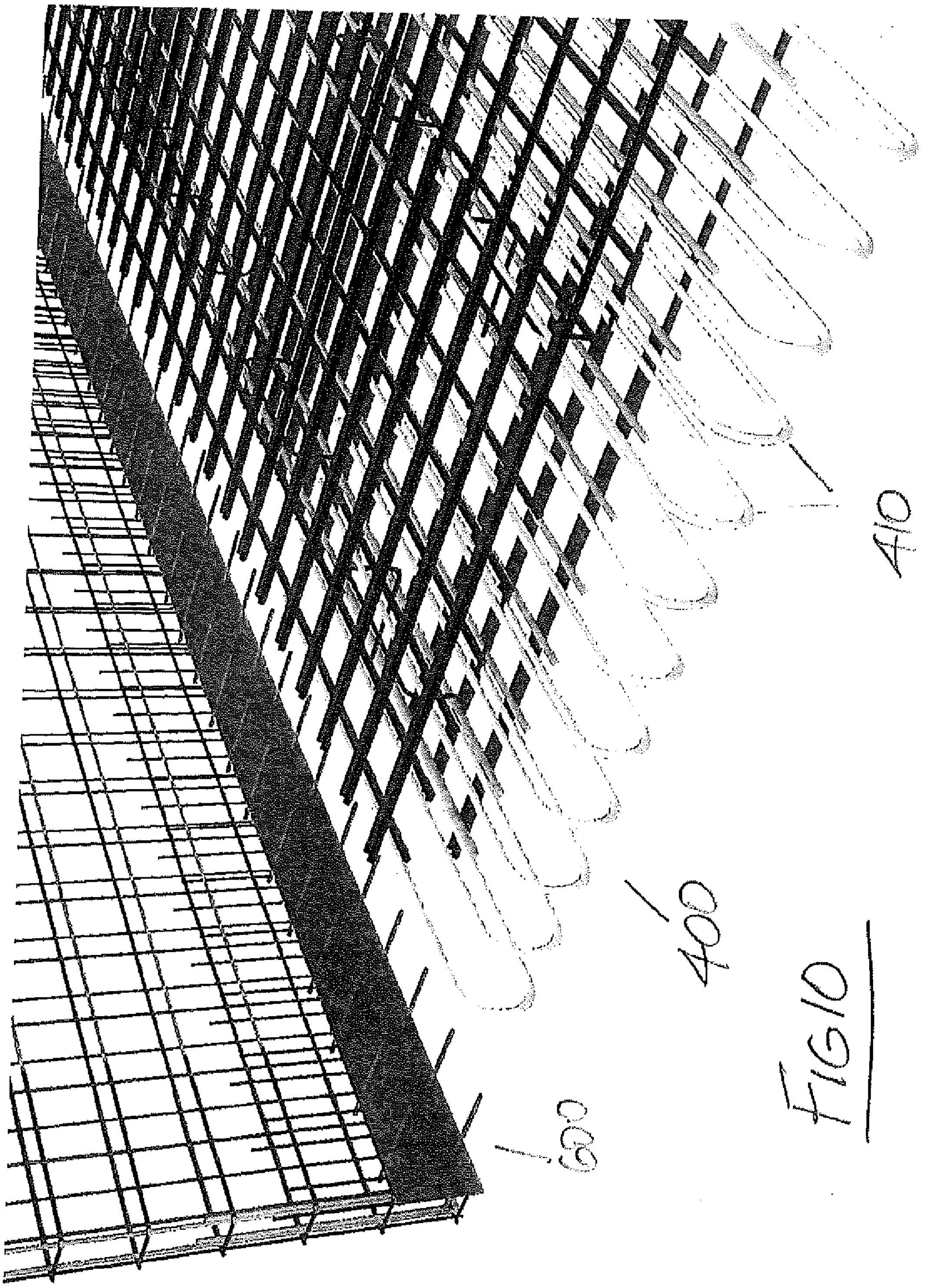

FIG10

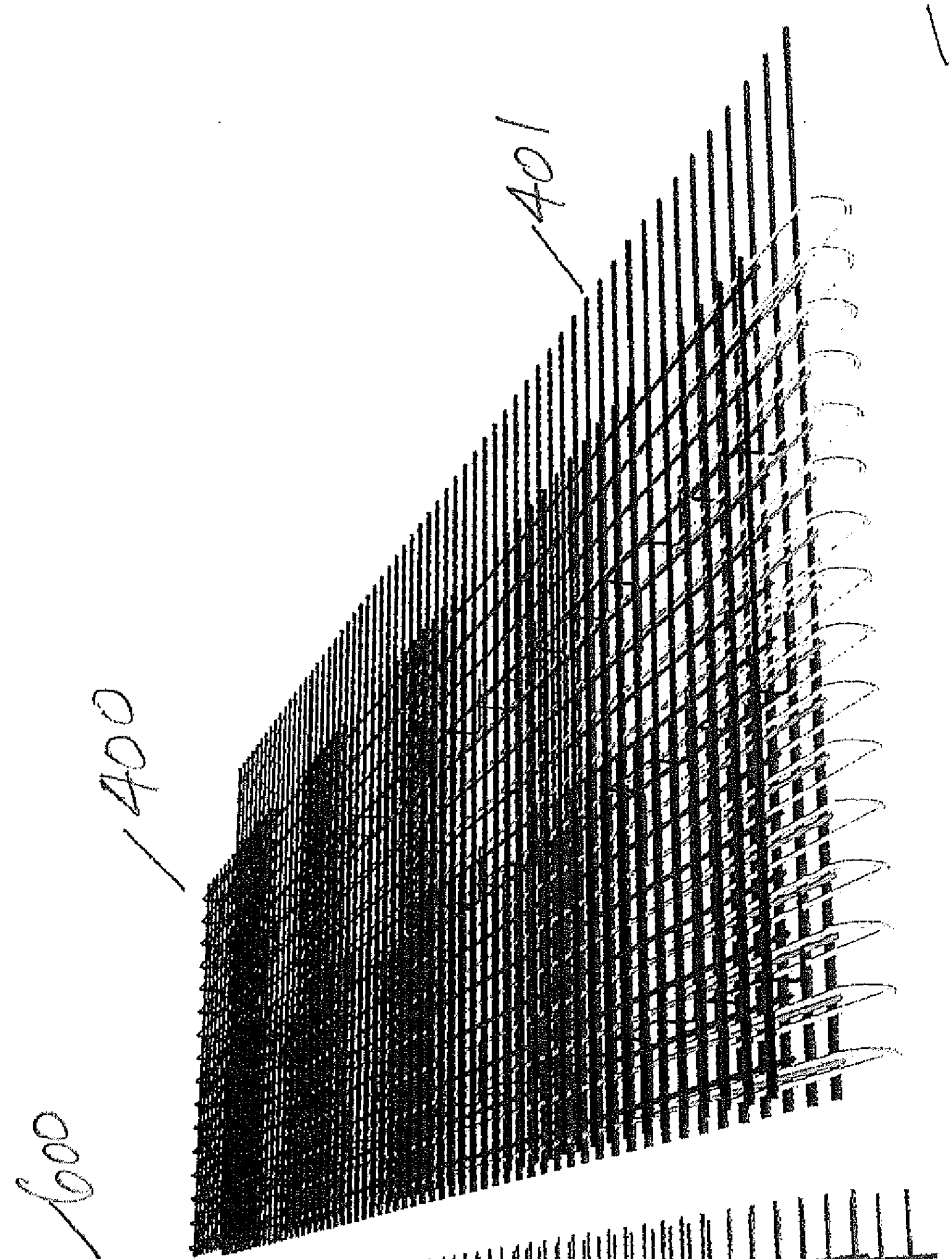

FIG 11

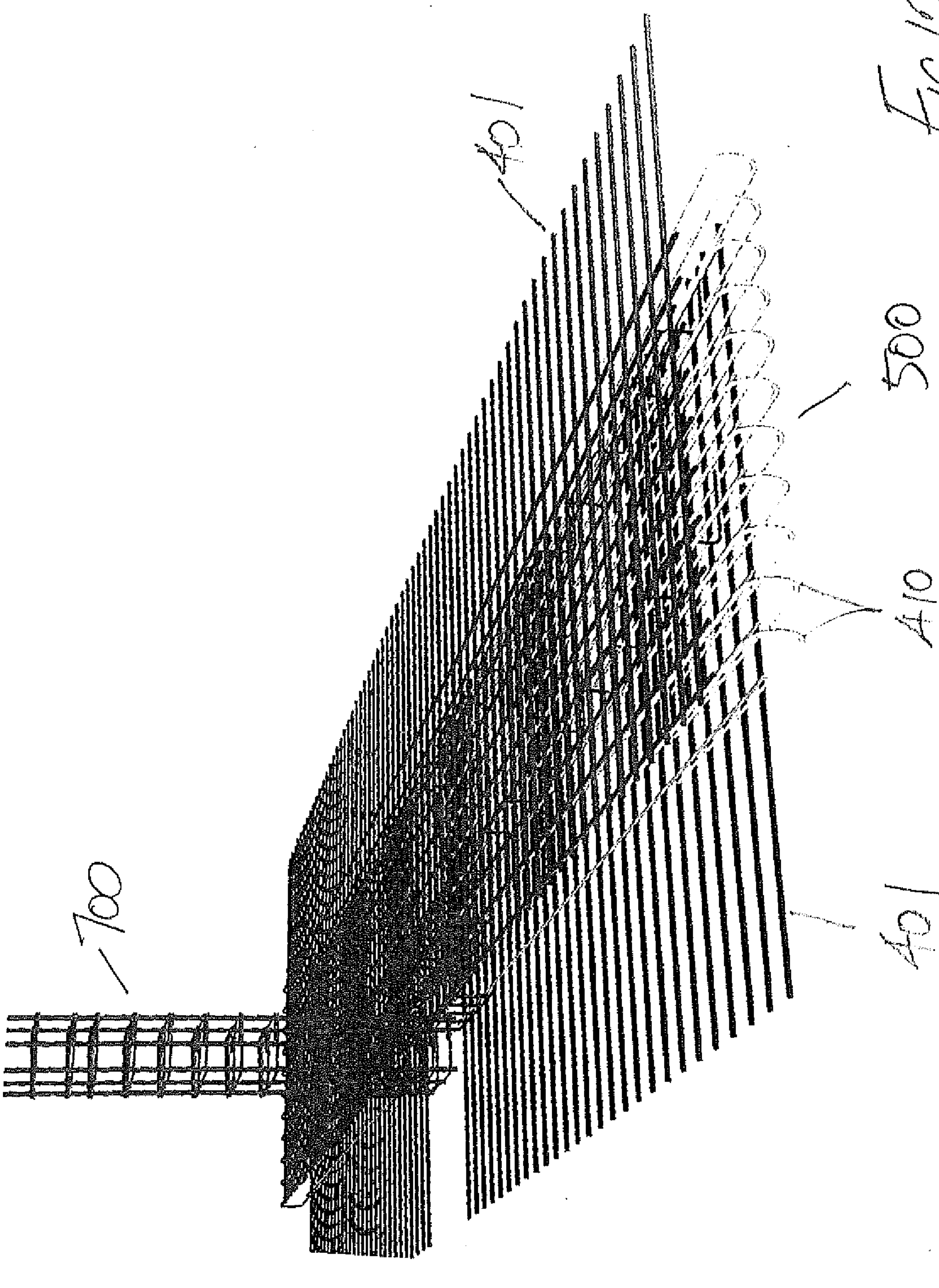

FIG 12

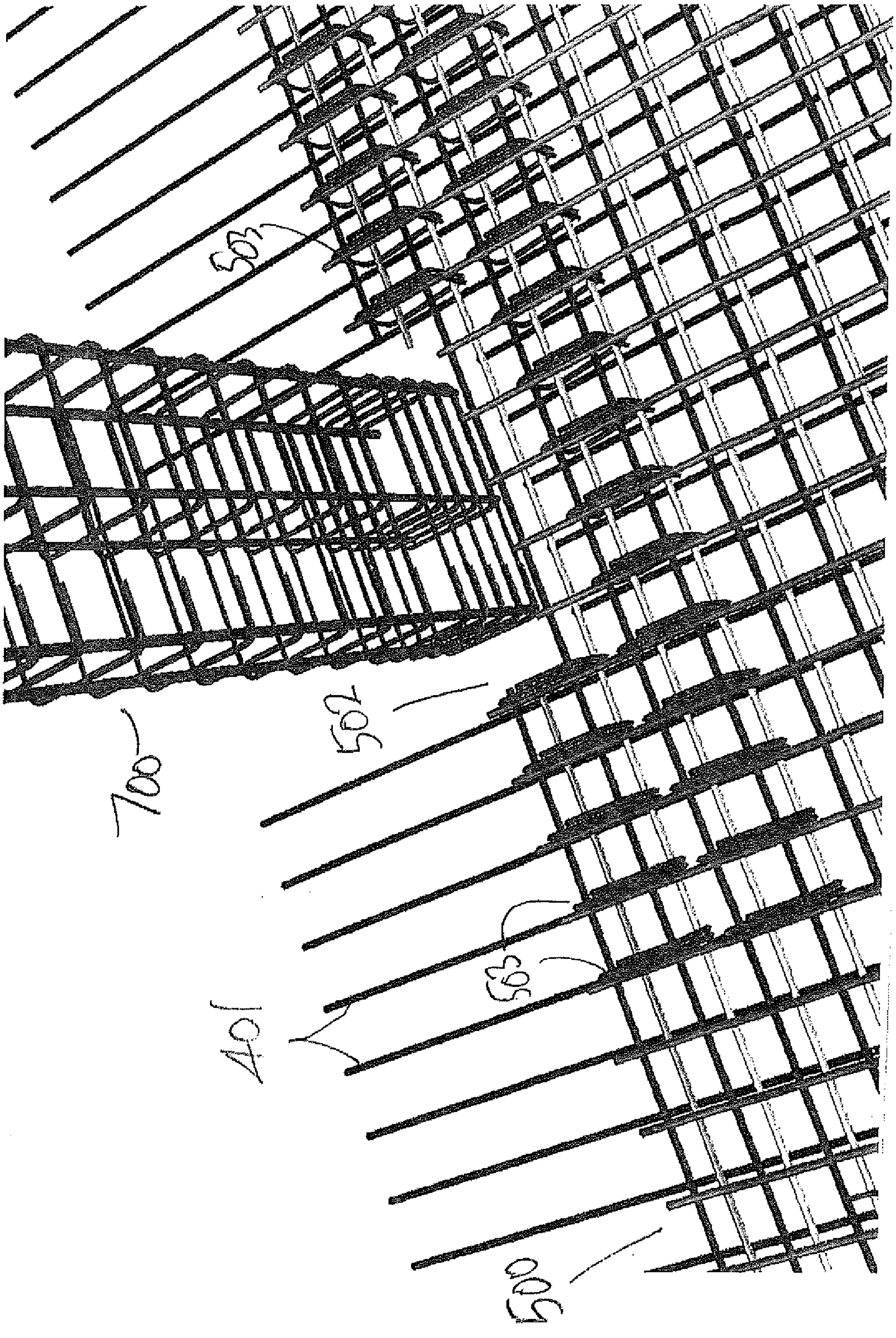

FIG 13