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(72) Inventors:
• **Debondt, Stefaan**
8551 Heestert (BE)
• **De Roose, Eline**
8680 Bovekerke (BE)

(71) Applicant: **NV Bekaert SA**
8550 Zwevegem (BE)

(74) Representative: **Messely, Marc**
NV Bekaert SA
D.I.E.
Bekaertstraat 2
8550 Zwevegem (BE)

(54) **Wire mesh net**

(57) A mesh net, said mesh being woven from single steel wires with a shape deformation in a bent spiral-shape, pairs of said single bent spiral-shaped wires being engaged at engagement points along their length,

characterized in that at least parts of bent wires disposed between two adjacent engagement points along the single bent spiral-shaped wires have an additional shape deformation on the bent wires.

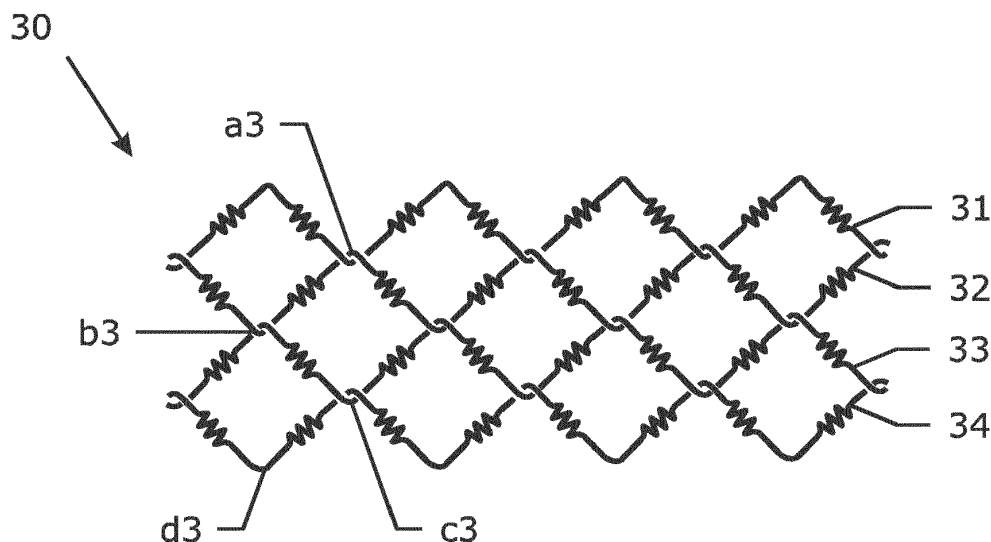


Fig. 2b

Description

Technical Field

[0001] The invention relates to a mesh net with steel wires.

Background Art

[0002] Mesh nets have been used for a gravel screen or for protection fences against falling rocks. Thanks to the development of chain linking technique, mesh nets made from chain linked steel wire are widely applied due to their high tensile strength, high breaking load and easy installation. Also, chain-linked wire mesh nets are recently implemented in fish farming. Chain-linked mesh nets made from steel wires are strong and thus keep the aquatic life controlled and contained and protect the aquatic life inside the net against predators such as sharks, sea lions, and seals.

[0003] The chain-linked wire mesh net is a fence of steel wires woven into a diamond pattern. The meshes have a dimension that is smaller than the dimension of the rocks when using as a gravel screen or that is smaller than the dimension of fish when using as fish farming net. Each steel wire is preformed by bending so that it exhibits a wavy pattern with maxima and minima. The maxima of a steel wire interlock with the minima of a neighbouring wire to form the patterns of a series of diamonds.

[0004] This type of chain-linked wire mesh nets are expected to have high breaking load and high energy absorption capability. When using for protection fences, the fence net should be able to absorb the high impact energy of falling rocks. While functioning as fish farming net, the net should be able to endure high weight since the load of the hanging net itself is considerable. An example of a typical dimension of a fish farming net is 30m x 30m x 15m, the last dimension being the depth of the net inside the water and the first two dimensions being the width and length of the net at the water surface. As a matter of example only, a net made of galvanized steel wire and of the above-mentioned dimensions has a weight above 4 metric Tonnes.

[0005] A typical chain-linked wire mesh in the prior art is schematically shown in Fig.1 (a) while a side view of such a chain-linked wire mesh is illustrated in Fig. 1(b). The wire mesh net is stretched during application. In ideal situation, the chains of steel wires are in identical shape and all the maxima of a steel wire are in good contact with all the minima of a neighbouring wire. In such a case, the load is or can be homogeneously distributed. Even in this ideal situation, the energy absorption ability of the net against impact is limited due to the stiffness of the wire mesh. In practice, due to the imperfect chain link and/or the following handling process for the wire mesh nets, the shape of steel wire chains could have more or less distance from each other. Therefore, local contact

stresses can be quite different between different contact points, because of inhomogeneous loading, e.g. cage edge versus cage walls and because of inhomogeneous mesh opening dimensions. Localized wear both weakens the mesh/net and accelerates local corrosion; it limits mesh/net life time. Local contacts with highest stress level will fail first and increase stress level in their neighbours' contact areas, which is propagation of early failure.

Disclosure of Invention

[0006] It is an object of the invention to avoid the disadvantages of the prior art.

[0007] It is also an object of the invention to provide a wire mesh net with sufficient resilience.

[0008] It is still another object of the invention to provide a wire mesh net with a prolonged life time.

[0009] According to the present invention, it is provided a mesh net, said mesh being woven from single steel wires with a shape deformation in a bent spiral-shape, pairs of said single bent spiral-shaped wires being engaged at engagement points along their length, characterized in that at least parts of bent wires disposed between two adjacent engagement points along the single bent spiral-shaped wires have an additional shape deformation on the bent wires.

[0010] A typical chain-linked wire mesh in the prior art is schematically shown in Fig.1 (a). Pairs (11,12,13,14) of single spiral-shaped wires being engaged at engagement points (a1,b1,c1,d1) along their length. Fig. 1 (b) is a side view of such a chain-linked mesh net. Herein, engagement points a1,b1; b1,c1 and c1,d1 are respectively considered as adjacent engagement points along respectively the single bent spiral-shaped wires 12; 13 and 14. In the other words, this is a fence of steel wires 11, 12, 13, 14 woven into a diamond pattern. Each steel wire is preformed by bending so that it exhibits a wavy pattern with maxima (e.g. point b1 for wire 11 and points a1, a1' for wire 12 as shown in Fig. 1(a)) and minima (e.g. point a1 and a1' for wire 11 and point b1 for wire 12 as shown in Fig. 1(a)). The maxima of a steel wire interlock with the minima of a neighbouring wire to form the patterns of a series of diamonds. The intersection of line a1a1' and line b1 b1' is defined as point o in Fig. 1(a). As shown in Fig. 1(a), the half of distance between two parallel and adjacent but not engaged wires (e.g. wires 11, 14) is defined as the amplitude of the bent spiral-shaped wire (distance of ob1 or ob1'). The distance of two adjacent minima along the single bent spiral-shaped wire (e.g. distance a1a1') is defined as the wavelength of the bent spiral-shaped wire.

[0011] As shown in Fig. 1 (a) and (b), the wires between the adjacent engagement points a1,b1; b1,c1 and c1,d1 along respectively the single bent spiral-shaped wires 12, 13, and 14 merely have a shape deformation following the spiral-shaped wire. The wire mesh net is quite stiff due to the longitudinal stiffness of the wire. Herein, the longitudinal stiffness may also be referred as axial stiff-

ness, which is the resistance of the wire between the two adjacent joints to being compressed or elongated by an axial force, e.g. due to the wire mesh is pulled or stretched. Also, there is possibility that the load is not homogeneously distributed due to the bad contacts at certain engagement points.

[0012] According to the invention, as shown in Fig. 2, at least parts of bent wires disposed between two adjacent engagement points are further deformed. In this way, the deformed wires have additional structural elongation and resilience is introduced into the wire mesh nets. The wire mesh nets have high energy absorption capability, which is normally limited due to the stiffness of the wire.

[0013] According to the present invention, the steel wires of said wire mesh may have a wire diameter smaller than 4.0 mm, e.g. 2 mm or 3 mm. The steel wires may be made from carbon steel, e.g. high carbon steel and low carbon steel, and stainless steel or duplex stainless steel. The steel wire may be made from high carbon steel having carbon content in the range of 0.2 to 1.5 weight percent. As an example, a high carbon steel can have a carbon content ranging between 0.2 wt% and 0.8 wt%, a manganese content from 0.3 wt% to 0.80 wt%, a silicon content ranging from 0.10 wt% to 0.50 wt%, a maximum sulphur content of 0.05 wt%, a maximum phosphorus content of 0.05 wt%, the remainder being iron and possible traces of copper, chromium, nickel, vanadium, molybdenum or boron. Alternatively, the steel wire can be a low carbon steel where - possibly with exception for silicon and manganese - all the elements have a content of less than 0.50 % by weight, e.g. less than 0.20 % by weight, e.g. less than 0.10 % by weight. E.g. silicon is present in amounts of maximum 1.0 % by weight, e.g. maximum 0.50 % by weight, e.g. 0.30 % by weight or 0.15 % by weight. E.g. manganese is present in amount of maximum 2.0 % by weight, e.g. maximum 1.0 % by weight, e.g. 0.50 % weight or 0.30 % by weight. In order to improve corrosion resistance, the wires of the mesh nets can be made from stainless steel and in particular duplex stainless steel.

[0014] Preferably, said steel wires have a coating selected from at least any one of zinc, zinc aluminium alloy, zinc aluminium magnesium alloy, copper alloy, e.g. copper nickel alloy, and polymers, e.g. polyethylene (PE), High-density polyethylene (HDPE), polyvinyl chloride (PVC), and polyethylene terephthalate (PET). Thus, the wire mesh nets have corrosion resistance which is important in harsh environment. The wire may also have antifouling coatings, in particular for marine application.

[0015] Preferably, said steel wires have a tensile strength greater than 600 MPa. More preferably, said steel wires have a tensile strength greater than 900 MPa. Most preferably, said steel wires have a tensile strength greater than 1200 MPa. This higher tensile strength can be obtained by different methods, such as using steel wires with higher carbon content or by subjecting the steel wires to a higher drawing reduction or by hardening treat-

ment (precipitation, phase transformation) or by a combination of such methods. The steel wires may be in a cold drawn final stage. The higher tensile strength of one or more steel wires may result in steel wires with a higher breaking load and/or in steel wires with a lower weight. The resulting net can be stronger due to the use of steel wires with a high breaking load or can be lighter due to the use of steel wires with a smaller diameter.

[0016] The steel wires between said two adjacent engagement points are nonlinear. Preferably, distances of said two engagement adjacent points along the single spiral-shaped bent wires are substantially equal. This would result in a homogeneous diamond pattern and a corresponding relatively uniform load distribution.

[0017] Preferably, the additional deformation has amplitude smaller than the half of the wavelength of the bent spiral-shaped wire. More preferably, the amplitude of additional deformation is also smaller than the amplitude of the bent spiral-shaped wire. As an example, at least part of the bent steel wires between said two adjacent engagement points along the single spiral-shaped bent wires are deformed into spiral, crimped and/or looped shape. Other shape of deformation between said two adjacent engagement points of the bent wires are also possible. The deformation can be on the same plane of the wire mesh net. The deformation can also be two or three dimensional. The shape deformation between said two adjacent engagement points of the bent wires introduces resilience between said two adjacent engagement points of the wires. In the other word, the longitudinal stiffness of the wires between said two adjacent engagement points is reduced due to the shape of the wire.

[0018] The wire mesh nets according to the present invention can be used for slope or rock fall protection. The wire mesh nets according to the present invention can also be used for fish farming. A chain-link fence having a high resilience according to the invention may also be used in the mining industry where there is a demand for high energy absorption.

Brief Description of Figures in the Drawings

[0019]

Figure 1(a) schematically shows a typical chain-linked wire mesh in the prior art; Fig. 1(b) illustrates a side view of such a chain-linked wire mesh of Fig. 1(a).

Figure 2 (a) -(c) each shows a part of the wire mesh nets according to the invention.

Figure 3 shows a side view of a wire mesh according to the invention.

Mode(s) for Carrying Out the Invention

[0020] The wire mesh net is made of a chain-link fence of steel wires, e.g. high carbon steel wires where the steel wires are provided with a corrosion-resistant coating.

[0021] Figure 2 (a) shows an example wire mesh net 20 according to the present invention, wherein at least part of the bent steel wires between said two adjacent engagement points a2, b2 and c2,d2 along the single spiral-shaped bent wires 22 and 24 are spiral-shaped. As another example, as shown in Fig. 2 (b), the steel wires of the mesh net 30 between said two adjacent engagement points a3,b3; b3,c3 and c3,d3 along respectively the single spiral-shaped bent wires 32, 33 and 34 are crimped. As yet another example wire mesh net 40, as shown in Fig. 2 (c), at least parts of the bent steel wires between said two adjacent engagement points b4,c4 along the single spiral-shaped bent wires 43 are looped. The amplitude of these additional deformation on the bent steel wires between said two adjacent engagement points are as example smaller than the half of the wavelength of the bent spiral-shaped wire and also smaller than the amplitude of the bent spiral-shaped wire. The bent steel wires between said two adjacent engagement points a3,b3; b3,c3 and c3,d3 along the single spiral-shaped bent wires may also have a combination of different type of shape deformation, e.g. crimped, spiral-shaped, or looped. The shape deformation can be made by commercially available machines for shaping wires. The shape deformation on the bent steel wires between said two adjacent engagement points can be performed before or after the chain-linking of the wire mesh.

[0022] Fig. 3 illustrates a side view of part of the wire mesh net according to the invention shown in Fig. 2(b), wherein the bent steel wires between two adjacent engagement points a3,b3; b3,c3 and c3,d3 along the single spiral-shaped bent wires 32, 33 and 34 are crimped. The wire mesh net 30 is made up of individual spirally bent steel wires 31, 32, 33, 34. The adjacent wires 31,32; 32,33; and 33,34 are woven together creating adjacent engagement points a3,b3; b3,c3, and c3, d3. At least part of the bent wires between the adjacent engagement points a3,b3; b3,c3, and c3, d3 are crimped. In this specific example, the wires between two adjacent engagement points are crimped in a plane perpendicular to the plane of the wire mesh net, as shown in Fig. 3. Alternatively, the wires between two adjacent engagement points may also be crimped in the plane of the wire mesh net.

Claims

1. A mesh net, said mesh being woven from single steel wires with a shape deformation in a bent spiral-shape, pairs of said single bent spiral-shaped wires being engaged at engagement points along their length, **characterized in that** at least parts of bent wires disposed between two adjacent engagement points along the single bent spiral-shaped wires have an additional shape deformation on the bent wires.
2. A mesh net according to claim 1, wherein said steel

wires have a wire diameter smaller than 4.0 mm.

3. A mesh net according to claim 1 or 2, wherein said steel wires have a coating selected from at least any one of zinc, zinc aluminium alloy, zinc aluminium magnesium alloy, copper alloy, and polymers.
4. A mesh net according to any one of the preceding claims, wherein said steel wires are made from carbon steel, stainless steel or duplex stainless steel.
5. A mesh net according to any one of the preceding claims, wherein said steel wires have a tensile strength greater than 600 MPa.
6. A mesh net according to any one of the preceding claims, wherein said steel wires have a tensile strength greater than 1200 MPa.
7. A mesh net according to any one of the preceding claims, wherein said steel wires are in a cold drawn final stage.
8. A mesh net according to any one of the preceding claims, wherein distances of each pair of two adjacent engagement points along the single bent spiral-shaped bent wire are substantially equal.
9. A mesh net according to any one of the preceding claims, wherein the additional deformation has amplitude smaller than the half of the wavelength of the bent spiral-shaped wire.
10. A mesh net according to any one of the preceding claims, wherein the additional deformation has amplitude smaller than the amplitude of the bent spiral-shaped wire.
11. A mesh net according to any one of the preceding claims, wherein at least parts of bent wires disposed between two adjacent engagement points along the single spiral-shaped bent wires are spiral-shaped.
12. A mesh net according to any one of the preceding claims, wherein at least parts of bent wires disposed between two adjacent engagement points along the single spiral-shaped bent wires are crimped.
13. A mesh net according to any one of the preceding claims, wherein at least parts of bent wires disposed between two adjacent engagement points along the single spiral-shaped bent wires are looped.
14. A mesh net according to any one of the preceding claims, wherein said mesh net is used for slope or rock fall protection.
15. A mesh net according to any one of the preceding

claims, wherein said mesh net is used for fish farming.

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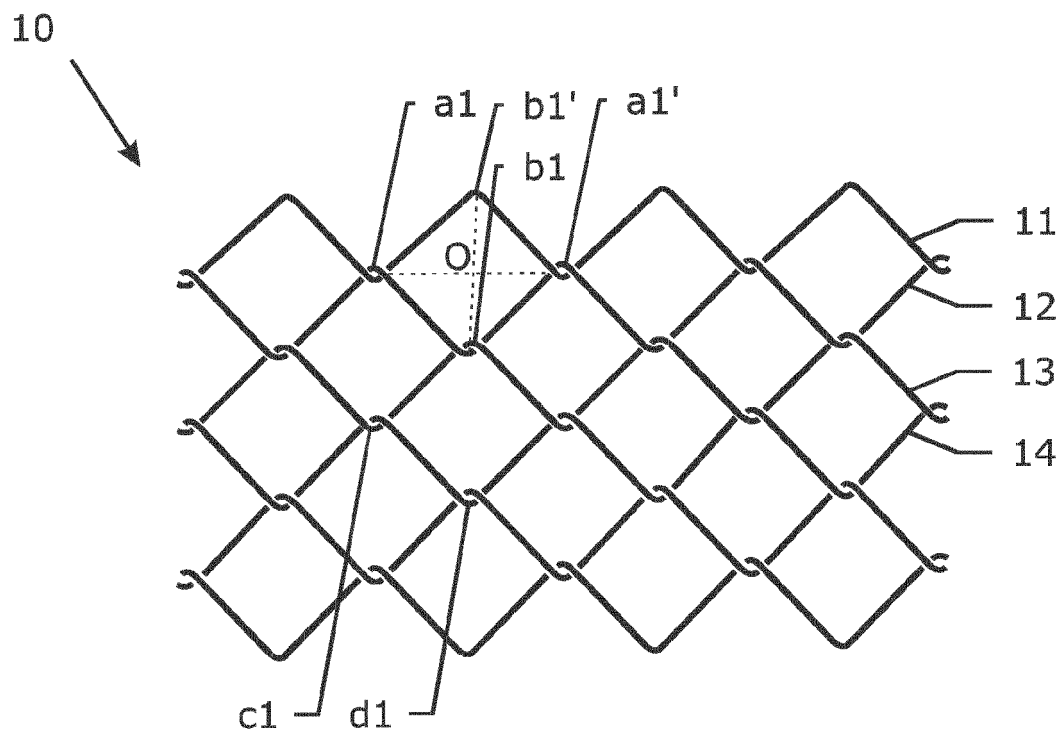


Fig. 1a

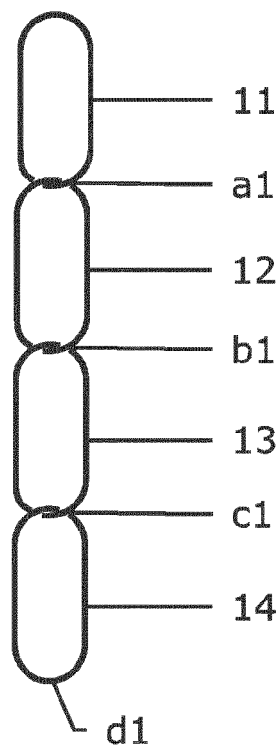


Fig. 1b

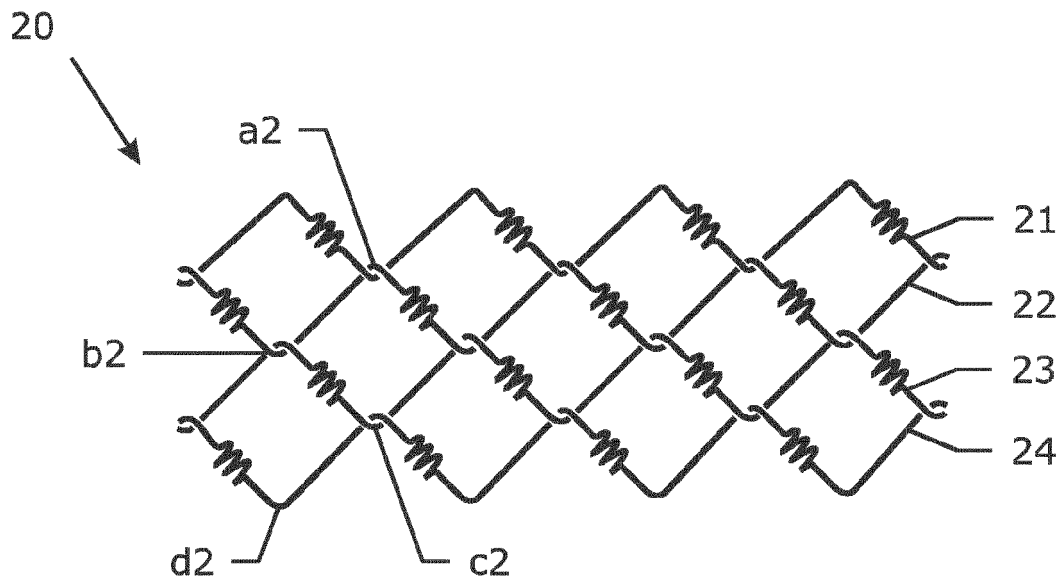


Fig. 2a

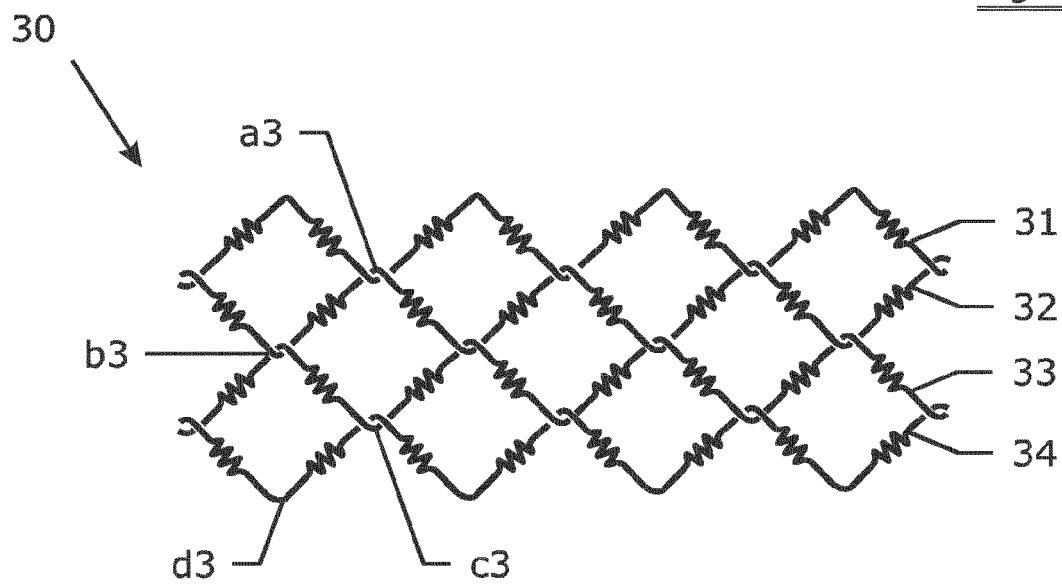


Fig. 2b

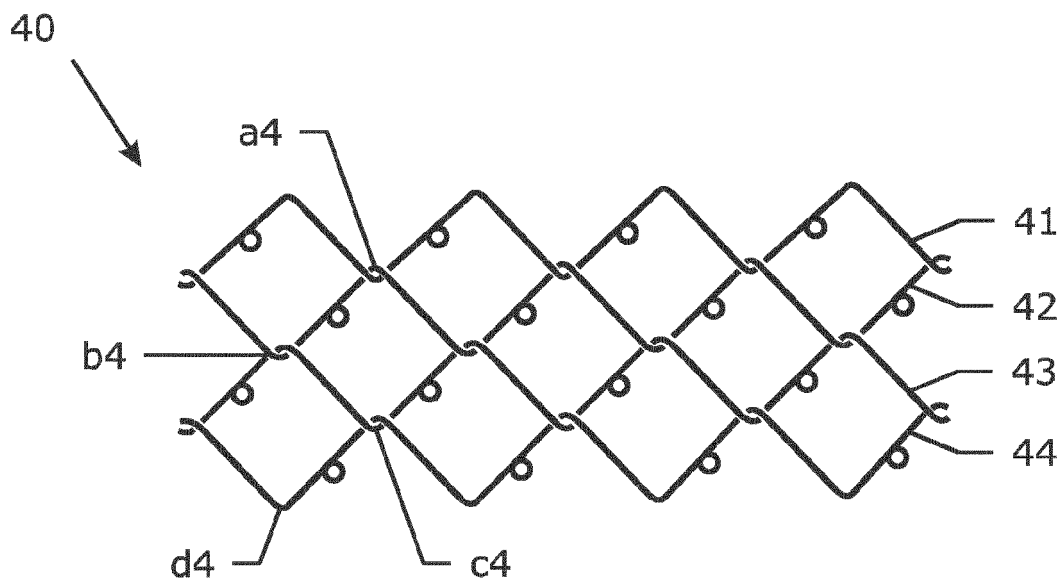


Fig. 2c

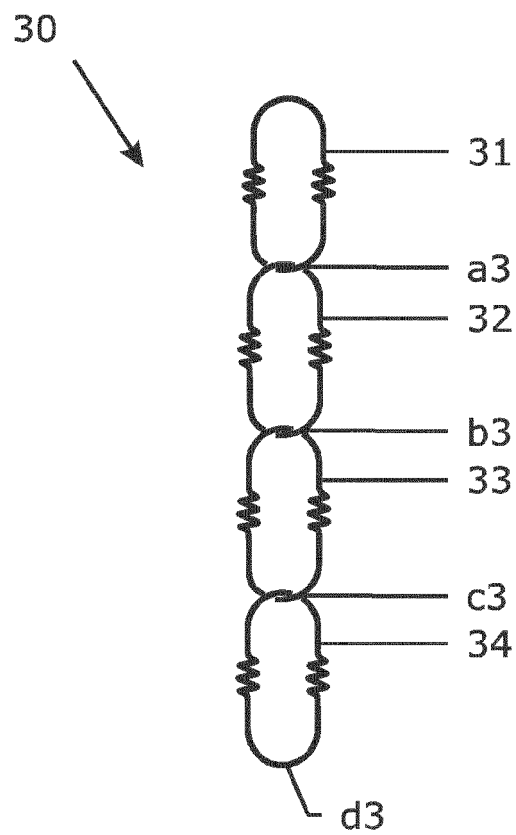


Fig. 3



EUROPEAN SEARCH REPORT

Application Number
EP 15 15 4679

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			TECHNICAL FIELDS SEARCHED (IPC)
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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 3 August 2015	Examiner Stern, Claudio
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
ON EUROPEAN PATENT APPLICATION NO.**

EP 15 15 4679

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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