

(19) **DANMARK**

(10) **DK/EP 2994253 T3**



(12) **Oversættelse af  
europæisk patentskrift**

Patent- og  
Varemærkestyrelsen

- 
- (51) Int.Cl.: **B 21 F 27/20 (2006.01)** **B 21 F 27/12 (2006.01)** **E 04 C 5/18 (2006.01)**  
**E 04 C 5/20 (2006.01)**
- (45) Oversættelsen bekendtgjort den: **2019-10-07**
- (80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2019-07-17**
- (86) Europæisk ansøgning nr.: **14727417.9**
- (86) Europæisk indleveringsdag: **2014-05-08**
- (87) Den europæiske ansøgnings publiceringsdag: **2016-03-16**
- (86) International ansøgning nr.: **EP2014059436**
- (87) Internationalt publikationsnr.: **WO2014180950**
- (30) Prioritet: **2013-05-08 BE 201300319**
- (84) Designerede stater: **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**
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- (54) Benævnelse: **Afstandsstykke til betonarmeringer**
- (56) Fremdragne publikationer:  
**DE-A1- 2 214 532**  
**DE-U1- 20 310 211**



# DESCRIPTION

## TECHNICAL FIELD

[0001] The present invention relates to methods for producing spacers for concrete reinforcements.

## BACKGROUND

[0002] Reinforcements for flat structures made of reinforced concrete are usually in the form of steel reinforcement nets. Often, one or more reinforcement nets are provided both at the top and the bottom of the flat structure, so that both tensile forces and pressure forces can be absorbed in an optimum manner.

[0003] During construction, the reinforcement nets are usually kept at the desired distance apart by means of spacers. Various types of spacer are known. One known spacer is a lattice girder having a triangular cross section. Such spacers possess great strength while at the same time using little material. However, they have the drawback that they can easily tip over. A known spacer which does not tip over so easily consists of two parallel and meandering longitudinal bars which are connected to each other by means of transverse bars which are securely welded to the longitudinal bars at right angles. However, these spacers are difficult to stack and cannot be readily dragged across the bottom reinforcement net. There is therefore a need for new spacers. There is also a need for new methods for producing spacers. Document DE 22 14 532 A1 discloses a method for producing spacers for concrete reinforcements and concrete structures. This document discloses to cut transverse bar portions on the construction site after bending elongate latices to form spacers. Furthermore this document does not disclose that transverse bars do not project or project by no more than 0.5 mm over the top and bottom longitudinal bars.

## SUMMARY

[0004] The present invention relates to methods for producing spacers for concrete reinforcements and/or concrete structures.

[0005] The present invention provides a method for producing spacers for concrete reinforcements and/or concrete structures comprising:

1. (a) providing at least four parallel longitudinal bars in a plane, comprising:
  - two peripheral longitudinal bars; and
  - at least one punching groove consisting of a pair of mutually adjacent longitudinal

- bars, positioned between said peripheral longitudinal bars;
2. (b) placing transverse bars perpendicularly on and/or under the longitudinal bars, and fastening the transverse bars to the longitudinal bars, so that a lattice structure is produced;
  3. (c) optionally, cutting off any part of the transverse bars overhanging the peripheral longitudinal bars;
  4. (d) cutting through or punching out of the transverse bar portions between the mutually adjacent longitudinal bars of the punching groove, optionally except for two to five of these transverse bar portions; thus producing two or more elongate lattices, optionally connected to each other by means of two to five uninterrupted transverse bars; and
  5. (e) bending the two or more elongate lattices; in this case producing two or more spacers for concrete reinforcements and/or concrete structures, each comprising two or more parallel and identical meandering longitudinal bars, connected to each other by transverse bars which are perpendicular to and laterally connected to the longitudinal bars; in which the transverse bars do not project or project by no more than 0.5 mm over the top and bottom longitudinal bars; and in which the spacers are optionally connected to each other by means of two to five uninterrupted transverse bars.

**[0006]** In specific embodiments of the method described in the present application, step (a) comprises unrolling and aligning at least four longitudinal bars in a plane; in which step (a), (b), (c) or (d) furthermore comprises cutting the longitudinal bars to a desired length. In further embodiments, a separate roll is provided for each longitudinal bar.

**[0007]** In certain embodiments, step (b) comprises unrolling, aligning and cutting the transverse bars from one or more rolls.

**[0008]** In specific embodiments, step (e) furthermore comprises turning each odd or even lattice obtained in step (d).

**[0009]** In certain embodiments, the transverse bars of the spacers project by no more than 0.2 mm over the top and bottom longitudinal bars.

**[0010]** In specific embodiments, the method furthermore comprises welding the transverse bars to the longitudinal bars. In specific embodiments of the method, two or more longitudinal bars have a different diameter. In certain embodiments of the method, two or more transverse bars have a different diameter.

**[0011]** In specific embodiments, the distance between the mutually adjacent longitudinal bars of the punching groove is at most 1 cm.

**[0012]** In certain embodiments, the transverse bars are situated at a regular distance apart. In specific embodiments, the spacers have a height of between 20 and 400 mm. In certain

embodiments, the spacers have a length of between 1 and 4 m.

**[0013]** In specific embodiments, the method furthermore comprises providing one or more longitudinal bars in said plane, said longitudinal bars being positioned between one of the peripheral longitudinal bars and the punching groove.

**[0014]** In specific embodiments, the longitudinal bars in step (a) form at least two bands, each of which contains two or more longitudinal bars, in which each pair of neighboring bands is separated from each other by a punching groove; and in which at least two of the bands have a different width.

**[0015]** The method described herein makes it possible to produce spacers in a simple and quick manner, in which the transverse bars do not project, or hardly project at all, over the outer longitudinal bars. The spacers obtained in this way can more easily be dragged across reinforcement nets than comparable existing spacers and are also, in specific embodiments, easier to stack. The methods described herein furthermore make it possible to produce spacers having a small height in a simple manner. The combinations of mutually connected spacers described herein make it possible to store and transport spacers more easily.

#### **DESCRIPTION OF THE FIGURES**

**[0016]** The following description of the figures of specific embodiments of the invention is only given by way of example and is not intended to limit the present explanation, its application or use. In the drawings, identical reference numbers refer to the same or corresponding parts and features.

**Fig. 1**

shows a production unit (10) for carrying out a specific embodiment of the method described herein.

**Fig. 2**

shows a lattice (5) obtained as an intermediate product according to a specific embodiment of the method described herein.

**Fig. 3**

shows a perspective view (A), cross section (B) and detail (C) of a spacer (1) according to specific embodiments.

**Fig. 4**

shows a perspective view (A), cross section (B) and detail (C) of a spacer (1') according to specific embodiments.

**Fig. 5A**

shows a lattice (5) obtained as an intermediate product according to a specific embodiment of the method described herein, for punching out transverse bar portions.

**Fig. 5B**

shows a lattice (5') obtained as an intermediate product according to a specific embodiment of the method described herein, after the transverse bar portions have been punched out.

**Fig. 5C**

shows a detail of a lattice (5') obtained as an intermediate product according to a specific embodiment of the method described herein, after transverse bar portions have been punched out.

**[0017]** In the description and figures, the following reference numerals are used:

1, 1' - spacer; 2, 3 - longitudinal bar; 4, 4' - transverse bar; 5, 5' - lattice; 6 - peripheral longitudinal bar; 7, 7', 8, 8' - longitudinal bar; 9 - overhang; 10 - production unit; 11, 12 - roll; 13 - guiding station; 14 - alignment station; 15 - welding station; 16 - trimming line; 17, 18 - punching line; 19 - cutting station; 20 - press; 21 - collecting station.

**DESCRIPTION OF THE INVENTION**

**[0018]** While potentially serving as a guide for understanding, any reference signs in the claims shall not be construed as limiting the scope thereof.

**[0019]** As used herein, the singular forms "a", "an", and "the" include both singular and plural referents unless the context clearly dictates otherwise.

**[0020]** The terms "comprising", "comprises" and "comprised of" as used herein are synonymous with "including", "includes" or "containing", "contains", and are inclusive or open-ended and do not exclude additional, non-recited members, elements or method steps. The terms "comprising", "comprises" and "comprised of" when referring to recited components, elements or method steps also include embodiments which "consist of" said recited components, elements or method steps.

**[0021]** Furthermore, the terms first, second, third and the like in the description and in the claims, are used for distinguishing between similar elements and not necessarily for describing a sequential or chronological order, unless specified. It is to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments described herein are capable of operation in other sequences than described or illustrated herein.

**[0022]** The values as used herein when referring to a measurable value such as a parameter, an amount, a temporal duration, and the like, is meant to encompass variations of +/-10% or less, preferably +/-5% or less, more preferably +/-1% or less, and still more preferably +/-0.1% or less of and from the specified value, insofar such variations are appropriate to ensure one or more of the technical effects envisaged herein. It is to be understood that each value as

used herein is itself also specifically, and preferably, disclosed.

**[0023]** The recitation of numerical ranges by endpoints includes all numbers and fractions subsumed within the respective ranges, as well as the recited endpoints.

**[0024]** All documents cited in the present specification are hereby incorporated by reference in their entirety.

**[0025]** Unless otherwise defined, all terms used in disclosing the concepts described herein, including technical and scientific terms, have the meaning as commonly understood by one of ordinary skill in the art. By means of further guidance, definitions for the terms used in the description are included to better appreciate the teaching of the present disclosure. The terms or definitions used herein are provided solely to aid in the understanding of the teachings provided herein.

**[0026]** In the present description, an object is understood to be "elongate" if the length of this object is greater than twice the width of this object; preferably, the length is three, four or five times the width of the object.

**[0027]** As used herein, the term "perpendicular" may comprise a certain degree of deviation from an exactly perpendicular orientation. More particularly, a first rod is deemed to be positioned perpendicularly to a plane or second rod if the angle between the longitudinal axis of the first rod and the plane, or the angle between the longitudinal axes of the first and second rods, is/are between  $89^\circ$  and  $91^\circ$ ; preferably between  $89.5^\circ$  and  $90.5^\circ$ ; and most preferably  $90^\circ$ .

**[0028]** As used herein, the term "parallel" may comprise a certain degree of deviation from an exactly parallel orientation. More particularly, a first rod is deemed to be positioned parallel with respect to a plane or second rod if the angle between the longitudinal axis of the first rod and the plane, or the angle between the longitudinal axes of the first and second rod, is between  $0.0^\circ$  and  $2.0^\circ$ ; preferably between  $0.0^\circ$  and  $1.0^\circ$ ; still more preferably between  $0.0^\circ$  and  $0.5^\circ$ , and most preferably  $0^\circ$ .

**[0029]** Reference throughout this specification to "one embodiment" or "an embodiment" means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment envisaged herein. Thus, appearances of the phrases "in one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment, but may. Furthermore, the particular features, structures or characteristics may be combined in any suitable manner, as would be apparent to a person skilled in the art from this disclosure, in one or more embodiments. Furthermore, while some embodiments described herein include some but not other features included in other embodiments, combinations of features of different embodiments are also envisaged herein, and form different embodiments, as would be understood by those in the art. For example, in the appended claims, any of the features of the

claimed embodiments can be used in any combination.

**[0030]** The spacers are intended, in particular, to keep two or more parallel concrete reinforcements, for example reinforcement nets for a flat structure, a desired distance apart. The flat structure may be a horizontal structure, such as a floor, or a vertical structure, such as a wall. The spacers may, for example, be used to keep reinforcement nets in prefabricated (prefab) hollow walls spaced apart. Such walls typically comprise two prefab concrete shells, in which each concrete shell comprises a reinforcement net. These reinforcement nets are kept at a distance from each other by one or more spacers. In this case, a hollow wall is obtained which can be filled with concrete at the building site.

**[0031]** More particularly, the present invention provides a spacer for concrete reinforcements and/or concrete structures comprising two or more parallel, mutually connected transverse bars which are perpendicular to and laterally connected to the longitudinal bars. The spacer has a meandering shape which makes a stable horizontal positioning of the spacer on a flat surface possible. The spacer is furthermore characterized by the fact that the transverse bars do not project, or hardly project at all, over the outer longitudinal bars. As a result, the spacers can be dragged across reinforcement nets in a simple and virtually unhampered manner. Below, these features will be explained in more detail.

**[0032]** The spacer described herein comprises two or more longitudinal bars. The longitudinal bars are positioned parallel with respect to each other, with a certain distance between the longitudinal bars. The longitudinal bars are connected to each other by means of transverse bars, so that a grate structure or lattice structure is obtained. As used herein, the term "lattice structure" refers to an open frame formed by wires, bars or the like which touch laterally or overlap, preferably in a regular pattern. The transverse bars are positioned perpendicularly to the longitudinal bars, so that a lattice structure with rectangular or square apertures is obtained. The lattice structure may be regarded as a net-shaped structure; or a ladder structure in the case of a spacer with only two longitudinal bars.

**[0033]** The spacer has a meandering shape. More particularly, the spacer is deformed to a meandering shape at right angles to an imaginary band plane which is determined by its parallel longitudinal bars in the straight position thereof. Such a shape may be obtained by positioning the longitudinal bars in a plane in straight form, positioning the transverse bars on and/or under the longitudinal bars, and bending the resulting flat lattice structure at right angles to the plane determined by the lattice structure to form a meandering shape (see below). The expression "meandering" or "meandering shape" is understood to mean a wavy and/or zigzag-shaped bent configuration. Examples of such a configuration are a trapezoidal bent configuration (see for example Fig. 3), a sinusoidal configuration, a triangular bent configuration, still other shapes, and combinations thereof. The wavy and/or bent configuration makes it possible to place the spacer in a stable position on a flat structure, such as a bottom reinforcement net, by means of the bottom longitudinal bar. Indeed, the meandering shape of the spacer ensures that the bottom longitudinal bar of the spacer forms a support surface which provides sufficient stability to prevent the spacer from tipping over during use thereof.

The top longitudinal bar in turn forms a support surface on which a reinforcement net can be placed.

In a simple form, the spacer only comprises two parallel longitudinal bars, more particularly a bottom longitudinal bar and a top longitudinal bar. A spacer of this type is particularly suitable for keeping concrete reinforcements a small distance apart, for example a distance up to 400 mm, preferably a distance up to 200 mm. However, the spacers described herein are not necessarily limited to these distances.

In specific embodiments, the spacer comprises three or more parallel longitudinal bars, more particularly a bottom longitudinal bar, a top longitudinal bar, and one or more intermediate longitudinal bars. This increases the strength of the spacer and is particularly important for spacers of significant height, for example a height of more than 200 mm. In the present application, the top and bottom longitudinal bars are also referred to as "outer longitudinal bars". The distances between an intermediate longitudinal bar and each of the two neighboring longitudinal bars may be equal or different. In specific embodiments, the distance between two neighboring longitudinal bars is always between 20 mm and 200 mm, preferably between 50 mm and 200 mm. With the spacer described herein, the transverse bars do not project, or hardly project at all, over the outer longitudinal bars. There is therefore no overhang, or hardly any overhang at all, of the ends of the transverse bars over the top and bottom longitudinal bars. More particularly, the transverse bars project at most 1.0 mm over the outer longitudinal bars; preferably at most 0.5 mm; more preferably at most 0.2 mm; or at most 0.1 mm; or at most 0.05 mm. The overhang of a transverse bar over a longitudinal bar can be measured as the distance of the end of the transverse bar (on the side of the respective longitudinal bar) compared to a plane which is perpendicular (90°) to the longitudinal axis of the respective transverse bar, and the respective longitudinal bar touches the outside of the spacer. An overhang of 0.5 mm thus means that if the spacer is positioned on a plane, there is a distance of at most 0.5 mm from the bottom longitudinal bar and the plane.

In specific embodiments, one or more transverse bars have straight ends. This means that the transverse bars are cut along a plane perpendicular to their longitudinal axis.

In specific embodiments, the ends of one or more transverse bars are oblique. This means that the transverse bars are cut at an angle, preferably along a plane which runs parallel to the longitudinal bars in the unbent state, and forms an angle of 30° to 50° with the transverse bars. Thus, the overhang of the transverse bars can be minimized further. In further embodiments, all transverse bars have oblique ends.

**[0034]** In specific embodiments, one or more transverse bars may have a straight and an oblique end.

Typically, the longitudinal bars and the transverse bars run along the entire length and the entire height of the spacer, respectively. Due to the minimal overhang of the transverse bars, the length of the transverse bars is therefore (virtually) equal to the height of the spacer. The height of the spacer, more particularly the distance between the outer (i.e. top and bottom) longitudinal bars, is usually between 20 mm and 400 mm. For a large number of applications, a height of at most 200 mm is sufficient. In a preferred embodiment, the spacer described herein thus has a height of between 20 mm and 200 mm, more preferably of between 50 mm and 200 mm.

However, the spacers described herein are not limited to such a height. In specific embodiments, the height is between 50 mm and 400 mm, preferably between 200 mm and 400 mm, more preferably between 200 mm and 360 mm, for example 300 mm. In specific embodiments, the height is approximately 20 mm, 30 mm, 40 mm, 50 mm, 60 mm, 70 mm, 80 mm, 90 mm, 100 mm, 110 mm, 120 mm, 130 mm, 140 mm, 150 mm, 160 mm, 170 mm, 180 mm, 190 mm, 200 mm, 220 mm, 240 mm, 260 mm, 280 mm, 300 mm, 320 mm, 340 mm, 360 mm, 380 mm, or 400 mm.

The length of the spacer is usually between 100 cm and 400 cm, preferably between 100 cm and 300 cm, more preferably between 150 cm and 250 cm, for example 200 cm. These values relate to the spacer in its bent (meandering) form. The length of the spacer (and the longitudinal bars forming the spacer) in the corresponding unbent state is usually between 10% and 100% greater than the length in the bent state, preferably between 15% and 30% greater.

With the spacers described herein, the transverse bars are arranged perpendicularly with respect to the longitudinal bars, with the transverse bars laterally touching the longitudinal bars. Preferably, each transverse bar touches each of the longitudinal bars of the spacer. In this way, a lattice structure comprising two or more parallel longitudinal bars and a series of parallel transverse bars which run perpendicular thereto is formed.

The distance between two neighboring transverse bars, measured along the longitudinal bars, is usually between 50 and 300 mm, preferably between 50 and 200 mm, more preferably between 100 and 150 mm. In specific embodiments, the transverse bars are placed at regular distances apart. However, in specific embodiments, two or more neighboring transverse bars may be placed closer together or further apart than other transverse bars in order to take an uneven load into account.

**[0035]** The longitudinal bars and transverse bars are preferably made of steel. In certain embodiments, the surface of the bars may not be smooth. For example, the surface may be provided with coiled ridges. This increases the surface of the bars, which may provide improved bonding of the steel and the concrete. However, this is not always preferred. Accordingly, in certain embodiments, the surface of the longitudinal and/or transverse bars may be smooth. In specific embodiments, the spacers may comprise a combination of bars with a smooth surface and bars with a non-smooth or textured surface.

Typically, the diameter of the longitudinal and transverse bars is between 2.0 and 10.0 mm. In specific embodiments, the diameter of the longitudinal and transverse bars is between 3.0 and 5.0 mm. The diameter of the longitudinal bars may be identical to the diameter of the transverse bars or different.

The diameter of the transverse bars may be adapted to the height of the spacer. More particularly, in the case of a higher spacer, transverse bars of greater strength, and thus of greater diameter, are used. For example, in specific embodiments, if spacers have a height of approximately 100 mm, transverse bars have a diameter of approximately 3.0 mm; whereas if spacers have a height of approximately 120 mm, the transverse bars have a diameter of approximately 3.2 mm.

In specific embodiments, two or more transverse bars have a different diameter or thickness. As a greater thickness typically leads to greater strength, this makes it possible to take into account local variations in load while using a minimum of material. More particularly, transverse

bars at positions subjected to a high load preferably have a larger diameter than the transverse bars at positions subjected to a smaller load. In other embodiments, all transverse bars are of equal diameter.

In specific embodiments, two or more longitudinal bars have a different diameter or thickness. More particularly, in specific embodiments, the spacers described herein comprise three or more (parallel) longitudinal bars, with two or more longitudinal bars having a different diameter or thickness. More particularly, the outer longitudinal bars may have a larger diameter than the longitudinal bars which are situated in between the outer longitudinal bars. This makes it possible to use less material, while still ensuring the stability and strength of the spacers. However, this does not exclude the possibility that all longitudinal bars may have the same diameter in other embodiments.

**[0036]** A combination of two or more spacers, as described above, is provided which are connected to each other, more particularly by means of a number of uninterrupted transverse bars. According to a specific embodiment of the method for producing spacers described herein (see below), such a combination forms an intermediate product. The combinations may furthermore be processed to form separate spacers, or may be offered as such. A combination of mutually connected spacers is preferably used for spacers of small height. Indeed, such low spacers are often quite difficult to handle, which may make their transportation and storage difficult. The combinations described herein can significantly facilitate the handling, transportation and storage of the spacers described herein. The spacers can easily be separated from one another on site by cutting through the uninterrupted transverse bars.

The combination described herein typically comprises a meandering lattice structure which comprises two or more spacers, in which the spacers are positioned next to each other, so that the transverse bars are in line with one another. The distance between two neighboring spacers is usually between 3 mm and 20 mm, for example approximately 15 mm. In this case, most transverse bars are interrupted (i.e. they do not continue in the space between two neighboring spacers), in which case the transverse bars of each spacer do not project over the top and bottom longitudinal bars, or project by no more than 1 mm, as described above. However, two or more transverse bars are not interrupted, as a result of which the spacers in the combination are connected to each other. All transverse bars are typically straight.

The longitudinal bars of the spacers are typically identical and placed parallel with respect to each other.

In the combination described herein, the spacers are connected to each other by means of at least two uninterrupted transverse bars, in order to ensure the rigidity of the connection. In specific embodiments, the combination comprises more than two uninterrupted transverse bars between each pair of neighboring spacers, but preferably not more than five. A higher number of transverse bars may increase the strength of the combination, but may also make it more difficult to separate the spacers. Typically, each pair of adjacent spacers in the combination is mutually connected by at least 2 uninterrupted transverse bars, and at most 3, 4, or 5 uninterrupted transverse bars. Furthermore, each spacer preferably comprises at least 3, at least 4, or at least 5 interrupted transverse bars (which do not project over the top and bottom longitudinal bars, or project by no more than 1 mm) for each uninterrupted transverse bar.

In specific embodiments, the combination described herein comprises at least three, at least four, at least five, or at least six spacers which are connected to one another. In this case, the spacers are again positioned next to each other, so that the transverse bars of the spacers are in line with one another, with each pair of adjacent spacers being mutually connected by at least two uninterrupted transverse bars. In specific embodiments, each uninterrupted transverse bar connects all the spacers in the combination to each other. Typically, such an embodiment is the easiest to produce. However, this is not imperative, and it is thus possible for one or more uninterrupted transverse bars not to connect all spacers to each other, and for different pairs of spacers in the combination to be connected to each other by means of different transverse bars.

**[0037]** The uninterrupted transverse bars preferably comprise the transverse bars which are situated at the ends of the spacers. An optional third uninterrupted transverse bar is preferably situated approximately halfway between the spacers.

**[0038]** The separate spacers in the combination described herein typically have a height of between 20 mm and 200 mm. However, it is possible for the combination to comprise one or more spacers of a different height, for example between 200 mm and 400 mm. The spacers connected to each other are typically of equal height, although it is possible for the combination to comprise spacers of a different height.

**[0039]** An unbent combination as described above is provided, more particularly a (flat) lattice structure which comprises two or more part-lattices, with each of the part-lattices being mutually connected by means of two to five uninterrupted transverse bars. Such a combination can often be bent more easily than separate part-lattices (see below), and can thus form a significant intermediate product when producing the spacers described herein.

**[0040]** The present invention furthermore provides methods for producing the spacers and/or combinations of mutually connected spacers described herein.

**[0041]** More particularly, the present invention provides a method which comprises:

1. (a) providing at least four parallel longitudinal bars in a plane, comprising
  - two peripheral longitudinal bars; and
  - at least one punching groove consisting of a pair of mutually adjacent longitudinal bars, positioned between the peripheral longitudinal bars;
2. (b) placing transverse bars perpendicularly on and/or under the longitudinal bars, and fastening the transverse bars to the longitudinal bars, so that a lattice structure is produced;
3. (c) optionally, cutting off any part of the transverse bars overhanging (or projecting from) the peripheral longitudinal bars;
4. (d) cutting through or punching out of the transverse bar portions between the mutually adjacent longitudinal bars of the punching groove, optionally except for two to five of these transverse bar portions; thus producing two or more elongate lattices, optionally

- connected to each other by means of two to five uninterrupted transverse bars; and
5. (e) bending the two or more elongate lattices; in this case producing two (or more) spacers for concrete reinforcements as described herein, in which the transverse bars do not project or project by no more than 0.5 mm over the top and bottom longitudinal bars, connected to each other by means of two to five uninterrupted transverse bars.

**[0042]** This method makes it possible to produce spacers, in which the transverse bars do not overhang or overhang only slightly, the outer longitudinal bars, and in an efficient and material-saving manner. The spacers obtained in this manner can be dragged across reinforcement nets in a simple and virtually unhampered manner. Below, these steps will be explained in more detail.

**[0043]** The method described herein comprises in a first step (a) providing at least four parallel longitudinal bars, usually in a plane. The four or more longitudinal bars comprise two peripheral longitudinal bars and at least one pair of mutually adjacent (neighboring) longitudinal bars different from the peripheral longitudinal bars. More particularly, at least one pair of mutually adjacent longitudinal bars (different from the peripheral longitudinal bars) forms a punching groove. A punching groove forms a line of separation where the transverse bars are cut and/or punched, so that the peripheral longitudinal bars and the longitudinal bars of the punching groove form the outer longitudinal bars of the resulting spacers (see below). Any other longitudinal bars form intermediate longitudinal bars of the spacers. The punching grooves divide the parallel longitudinal bars into two or more bands which are separated from each other by punching grooves, in which a separate spacer can be formed from each band.

**[0044]** In specific embodiments, at least five parallel longitudinal bars are provided, preferably six or more parallel longitudinal bars. In specific embodiments, six parallel longitudinal bars are provided, with one or two adjacent pairs of longitudinal bars forming one or two punching grooves, respectively. In specific embodiments, eight or more parallel longitudinal bars are provided, in which case at least three punching grooves are formed.

**[0045]** The longitudinal bars are typically positioned at a distance with respect to each other, corresponding to the distance between the neighboring longitudinal bars in the spacers described herein. However, each pair of mutually adjacent longitudinal bars which forms a punching groove is preferably placed as close together as possible, in order to reduce the loss of material during separation of the spacers (see below). In specific embodiments, the distance between a pair of mutually adjacent longitudinal bars which forms a punching groove is at most 20 mm and this distance is also referred to herein as the width of the punching groove. Preferably, each punching groove has a width of 0 mm to 20 mm, preferably between 0 mm and 15 mm, more preferably between 0 mm and 10 mm.

If the portions of the transverse bars are not cut but punched in the punching groove and the punching groove is too narrow, this may result in accelerated wear of the dies which are used for the punching-out operation. Preferably, the distance between a pair of mutually adjacent

longitudinal bars which forms a punching groove is at least 3 mm in such embodiments. In specific embodiments, this distance is approximately 15 mm. Such a distance may ensure minimal wear and little loss of material.

In specific embodiments, the distance between two mutually adjacent longitudinal bars is between 20 mm and 400 mm, preferably between 20 mm and 200 mm, more preferably between 50 mm and 200 mm (except between the mutually adjacent longitudinal bars which form a punching groove, as described above).

As has been described above, the parallel longitudinal bars together form two or more bands, in which case each pair of neighboring bands is separated from each other by a punching groove. Each band contains at least two longitudinal bars. The distance between the outer pair of longitudinal bars of a band is also referred to herein as the "width" of the respective band. This width determines the height of the spacer which can be obtained from the respective band by means of the method described herein.

In specific embodiments, two of the two or more bands are a different width. This makes it possible to produce two or more types of spacers of a different height simultaneously using one installation. Thus, it is possible to avoid the installation having to be completely changed over for each new height. This saving in changeover time makes it possible to achieve a more efficient and rapid production.

In specific embodiments, the longitudinal bars form at least three, at least five, at least eight, at least ten, or at least twelve bands which are separated from each other by punching grooves, in which case at least two bands have a different width.

**[0046]** In specific embodiments of the method described herein, providing the at least four parallel longitudinal bars comprises unrolling and (straightening and) aligning these longitudinal bars in a plane.

In a preferred embodiment, each of the four or more longitudinal bars comes from a separate roll. This can increase the production rate and makes it possible, if desired, to combine different kinds of longitudinal bars, for example longitudinal bars of different diameters. In specific embodiments, the four or more longitudinal bars thus comprise at least two longitudinal bars of different diameters. Thus, it is possible to produce spacers which comprise two or more longitudinal bars of a different diameter or thickness, as described above.

When the longitudinal bars are unrolled from one or more rolls, the method described herein furthermore also comprises cutting the longitudinal bars to a desired length. This cutting may take place immediately after unrolling has taken place or in a subsequent stage of the production process, for example after a number of transverse bars have been welded onto the longitudinal bars. More particularly, this cutting off may be effected in step (a), (b), (c), or (d). In specific embodiments, this takes place after fastening the transverse bars in step (d), and before bending the lattices in step (e). The desired length depends on the desired length of the spacers, and is usually between 115 cm and 600 cm, preferably between 200 cm and 300 cm, for example 230 to 260 cm.

**[0047]** The method described herein furthermore comprises (b) perpendicularly positioning transverse bars on and/or under the longitudinal bars, and fastening the transverse bars to the longitudinal bars, so that a lattice structure is obtained. The sequence of positioning the

transverse bars and the longitudinal bars is not critical for the method described herein. In specific embodiments, the longitudinal bars are first positioned along a specific length, following which one or more transverse bars are positioned on and/or under the longitudinal bars. In other embodiments, one or more transverse bars are positioned first, following which the longitudinal bars are positioned on and/or under the transverse bars. In a preferred embodiment, the method described herein is carried out as a (partly) continuous process. In this case, longitudinal bars may, for example, be unrolled from a roll and the transverse bars are positioned on and/or under the longitudinal bars as the longitudinal bars are being unrolled.

The transverse bars run parallel to one another and are perpendicular to the longitudinal bars, and laterally touch the longitudinal bars. In this case, a lattice structure is formed. In specific embodiments, all transverse bars are on the same side of the plane which is determined by the longitudinal bars. However, it is provided that, in specific embodiments, transverse bars may be present on both sides of this plane. Thus, it is for example possible to ensure that the transverse bars are mainly or only situated on the convex side of the bending; or are mainly or only situated on the concave side of the bending during the bending operation in step (e) (see below).

In specific embodiments, the transverse bars are positioned and fastened to the longitudinal bars one by one. In this case, a subsequent transverse bar is only positioned once the preceding transverse bar has been fastened. In other embodiments, several successive transverse bars are positioned before the transverse bars are fastened.

The transverse bars are preferably fastened to the longitudinal bars by welding. More particularly, bars are welded together at the points of contact between the bars.

In specific embodiments of the invention described herein, positioning the transverse bars comprises the unrolling, (straightening,) aligning and cutting of the transverse bars from one or more rolls. In specific embodiments, the transverse bars come from one and the same roll. This is eminently suitable for producing spacers which only feature one type of transverse bar. If only a single roll is used for the transverse bars, the positioning and fastening of the transverse bars takes place step by step, for example transverse bar by transverse bar.

In specific embodiments, the transverse bars come from two or more rolls. This has the advantage that different types of transverse bars can be used, for example transverse bars of different diameters. In specific embodiments of the method described herein, two or more transverse bars accordingly have a different diameter.

**[0048]** Neighboring transverse bars are usually placed apart at a distance of between 50 and 300 mm, preferably of between 50 and 200 mm, more preferably of between 100 and 150 mm. In specific embodiments, the transverse bars are placed at regular distances apart. However, in specific embodiments it is provided that specific neighboring transverse bars are placed closed together or further apart than other neighboring transverse bars.

**[0049]** In specific embodiments, the transverse bars already have the desired length before they are positioned, so that there is no or hardly any overhang of the transverse bars over the two peripheral longitudinal bars after the transverse bars have been fastened. In other embodiments, the transverse bars are longer, so that there initially is an overhang. In specific

embodiments, the method described herein thus furthermore comprises a step (c) which comprises cutting the transverse bar overhang over the peripheral longitudinal bars.

In a preferred embodiment, there is an initial overhang during the positioning of the transverse bars, and the overhang is cut afterwards. This makes it possible to increase the production rate, since accurate placement of an accurately dimensioned transverse bar can usually be carried out less quickly than accurately cutting off an overhang.

**[0050]** As described above, the longitudinal bars of the punching groove or punching grooves form the outer longitudinal bars of the eventual spacers. In order to separate the spacers from each other, the transverse bars are cut and/or punched between the adjacent horizontal longitudinal bars of each punching groove.

In specific embodiments, the portions of transverse bars can be cut through or cut out in the punching grooves. Cutting such a transverse bar portion may be effected by means of one or two cutting operations. A single cutting operation typically suffices when the width of a punching groove is sufficiently small (at most 1 mm), so that the transverse bars project by less than 0.5 mm over the transverse bars after the cutting operation. Wider punching grooves typically require two cutting operations to prevent the transverse bars from projecting by more than 0.5 mm.

In specific embodiments, with the method described herein, the pieces of transverse bar are punched out between each pair of longitudinal bars forming a punching groove. The expression "punching out" or "punching" is understood to mean that a portion of transverse bar is cut out of the transverse bar between two adjacent horizontal longitudinal bars of a punching groove in a single operation. The removal of a portion of a transverse bar then does not comprise two separate cutting operations. This operation may be regarded as being analogous to punching or perforating, in which an opening is produced in a plate.

The cutting through and/or punching out is carried out in such a way that there is no overhang, or hardly any overhang, of the transverse bars over the outer longitudinal bars of the resulting lattices and the spacers formed therefrom (see below) after the cutting-through and/or punching-out operation. More particularly, the remaining overhang is at most 0.5 mm; preferably at most 0.2 mm; or at most 0.1 mm; or at most 0.05 mm. Cutting through and/or punching out may be carried out in such a manner that transverse bars with straight ends and/or oblique ends are formed, as described above.

In specific embodiments, all transverse bar portions are cut through or punched out in the punching groove or punching grooves. As a result of the cutting and/or punching, two or more separate (flat) lattices are thus formed which are bent in a subsequent step to form a spacer, as described herein. In specific embodiments, in order to effect the bending, each even or each odd lattice obtained in step (d) is turned or turned back, so that corresponding transverse bars of subsequent lattices are situated in each case at opposite sides of the lattices. As a result thereof, it is possible to stack the resulting spacers closer on top of each other. Turning is preferably carried out by rotating the lattice through 180° about the transverse axis or longitudinal axis, but may be effected by means of any combination of translational movements and/or rotations having the same effect.

In specific embodiments, all the transverse bar portions are cut through and/or punched out in one or more punching grooves, except two to five transverse bar portions which are not

interrupted. By cutting and/or punching, a lattice structure is thus formed which comprises two or more mutually connected (flat) part-lattices which are bent in a subsequent step to form a combination of spacers, as described herein. This may significantly facilitate the bending of spacers of a small height. In specific embodiments, two or more punching grooves are provided in step (a). In such embodiments, it is possible to punch out all the transverse bar portions in specific punching grooves, and to not interrupt two to five transverse bar portions in other punching grooves. Thus, for example, a large lattice structure can be subdivided into part-lattices, in which case each part-lattice may in turn be bent to form a combination of mutually connected spacers as described above.

In a preferred embodiment, the lattice comprises two or more punching grooves, and no transverse bar portions are cut through and/or punched out with two to five transverse bars in the lattice and, with all the other transverse bars, all the transverse bar portions are cut through and/or punched out in the punching grooves. Thus, all part-lattices are connected to each other by means of the same transverse bars.

**[0051]** In step (e), the (part-)lattices obtained in step (d) which may be connected to each other are bent by means of two to five uninterrupted transverse bars as described above. Typically, the lattices are bent at right angles to the plane determined by the original lattice obtained in step (d), in such a way that each of the bent longitudinal bars is in a plane which is perpendicular to the plane determined by the original lattice. In other words, the longitudinal bars are bent in an identical manner, each in a plane perpendicular to the longitudinal bars. In this case, a meandering spacer and/or a combination of mutually connected meandering spacers are obtained, as described above.

**[0052]** In an optional further step, the spacers and/or combinations of mutually connected spacers are stacked and tied together, preferably in packs of 10 to 50 spacers or combinations. The stacking and/or tying together may be carried out manually or may be automated.

As described above, in specific embodiments a combination of mutually connected spacers can be obtained in step (e). These can be cut at the factory or on site to form separate spacers as described herein. In specific embodiments, the method described herein thus comprises:

(f) cutting through and/or punching out any remaining transverse bar portions between two or more mutually connected spacers.

**[0053]** The method described above for producing spacers allows for efficiently producing the spacers described herein with a minimum of material loss. However, the spacers may also be manufactured by simply providing a lattice comprising two or more parallel longitudinal bars and a plurality of transverse bars, cutting off any part of the transverse bars overhanging the peripheral longitudinal bars, and bending the lattice, thereby obtaining a spacer as described herein comprising two or more longitudinal bars. Accordingly, further provided herein is a method for producing a spacer, said method not being covered by the invention and comprising:

1. (A) providing two or more parallel longitudinal bars in a plane, including two peripheral

- longitudinal bars;
2. (B) placing transverse bars perpendicularly on and/or under the longitudinal bars, and fastening the transverse bars to the longitudinal bars, so that a lattice structure is produced;
  3. (C) optionally, cutting off any part of the transverse bars overhanging (or projecting from) the peripheral longitudinal bars; and
  4. (D) bending the lattice structure; thereby obtaining a spacer for concrete reinforcements as described herein.

**[0054]** In this method, step (C) may be performed prior or after step (D). In preferred embodiments, step (C) is performed prior to step (D).

**[0055]** In specific embodiments, step (A) may comprise unrolling and (straightening and) aligning the longitudinal bars in a plane. In a preferred embodiment, each of the four or more longitudinal bars comes from a separate roll. This can increase the production rate and makes it possible, if desired, to combine different kinds of longitudinal bars, for example longitudinal bars of different diameters. In specific embodiments, the four or more longitudinal bars thus comprise at least two longitudinal bars of different diameters.

**[0056]** When the longitudinal bars are unrolled from one or more rolls, the method described herein furthermore also comprises cutting the longitudinal bars to a desired length. This cutting may take place immediately after unrolling has taken place or in a subsequent stage of the production process, for example after a number of transverse bars have been welded onto the longitudinal bars. More particularly, this cutting off may be effected in step (A), (B), or (C). In specific embodiments, this takes place after fastening the transverse bars in step (B), and before bending the lattices in step (D). The desired length depends on the desired length of the spacers, and is usually between 115 cm and 600 cm, preferably between 200 cm and 300 cm, for example 230 to 260 cm.

The details of steps (B) and (C) of the method as described above apply, *mutatis mutandis*, to steps (b) and (c), of the method described prior in this application.

**[0057]** The present invention will be illustrated by the following non-limiting embodiments.

## EXAMPLES

**[0058]** Fig. 1 is a representation of a production unit (10) for carrying out a specific embodiment of the method described herein. The unit is adapted for unrolling six transverse bars from six rolls (11). By means of a guiding station (13), the longitudinal bars are taken to an alignment station (14) where the bars are positioned parallel to each other in a plane.

The transverse bars are unrolled and cut from a single roll (12) and are positioned perpendicularly to the transverse bars one by one and welded onto the transverse bars in a

welding station (15). This is typically carried out at a rate of approximately two transverse bars per second.

**[0059]** In this case, a continuous lattice (5) is obtained, as illustrated in Fig. 2. The lattice (5) contains six parallel longitudinal bars, of which two are peripheral longitudinal bars (6), and two pairs of adjacent horizontal longitudinal bars (7 and 7'; 8 and 8'), with each pair (7 and 7'; 8 and 8') forming a punching groove. The distance between each pair of longitudinal bars forming a punching groove is smaller than the other distances between the longitudinal bars. Thus, three bands (a, b, c) are created, with a spacer being formed from each band.

**[0060]** The lattice is processed further in a first trimming line (16), in which the overhang of the transverse bars over the outer longitudinal bars (6) is accurately cut off on both sides. The overhang of the transverse bars is indicated in Fig. 2 by the hatched rectangles (9). Thereafter, the transverse bar portions between the first pair of longitudinal bars (7, 7') which forms a punching groove are punched out in a first punching station (17) and the transverse bar portions between the second pair of longitudinal bars (8, 8') are punched out in a second punching station (18). Finally, the longitudinal bars (6, 7, 7', 8, 8') are cut at an equal distance in a cutting station (19). Three lattices are obtained in each case, corresponding to the three bands (a, b, c).

**[0061]** The lattices are transported to a press (20), where they are bent to form a spacer as illustrated in Figures 3 and 4. Optionally, each even or odd lattice is turned for bending, so that the lattices can be stacked more easily.

**[0062]** Fig. 3A is a representation of a spacer (1) according to a specific embodiment of the present invention. The spacer (1) comprises two parallel and identical meandering (outer) longitudinal bars, more particularly a top longitudinal bar (2) and a bottom longitudinal bar (3). The longitudinal bars (2, 3) are connected by transverse bars (4) which are situated perpendicular to the longitudinal bars. There is no overlap of the transverse bars (4) beyond the longitudinal bars (2, 3). Each of the longitudinal bars is bent in a plane, so that the bottom longitudinal bar (3) permits stable positioning of the spacer (1) on a reinforcement net and the top longitudinal bar (2) permits stable positioning of a reinforcement net on the spacer (1).

Fig. 4A is a representation of a spacer (1') similar to the spacer illustrated in Fig. 3A, except that the transverse bars in the spacer (1) in Fig. 3A are situated on the rear side of the spacer, while the transverse bars in Fig. 4A are situated on the front side of the spacer (1'), as is also clear from the cross section along line A-A' and B-B' (Figures 3B and 4B), and the detailed view (Figures 3C and 4C).

By alternately stacking the spacer (1) from Fig. 3 and the spacer (1') from Fig. 4, the spacers (1, 1') can be stacked closer against one another than would be the case if spacers of the same type were to be stacked on top of one another.

**[0063]** In a last step, the spacers are collected and tied together in a collecting station (21).

**[0064]** In specific embodiments, the method described herein can be used to produce

combinations of mutually connected spacers. This is illustrated in Fig. 5A-C. The arrows in Fig. 5A and 5B show the direction of production.

Fig. 5A shows a lattice (5) with 18 parallel transverse bars (4, 4') which are positioned perpendicularly to 24 parallel longitudinal bars (6, 7, 7'). However, the person skilled in the art will understand that the method described herein can also be carried out using more or fewer transverse bars and longitudinal bars. The longitudinal bars (7, 7') form 11 punching grooves, so that the lattice contains 12 part-lattices, each of which can be bent to form a spacer with two longitudinal bars. However, due to their large length/width ratio, bending such part-lattices is very laborious. Likewise, the handling, transportation and storage of the eventual spacers is not easy.

Therefore, it may be advantageous, with the punching station (17) as described above, not to punch out all transverse bar portions in the punching grooves. It is possible, for example, to allow specific transverse bars to remain intact, as illustrated in Fig. 5B and 5C. These figures show a lattice (5'), in which all the transverse bar portions have been punched out in the punching grooves, except for four transverse bars (4'): two in the centre of the lattice and two at the ends thereof. Thus, the part-lattices and the resulting spacers can easily be bent to form a combination of spacers (1). After bending, the spacers (1) can readily be separated from one another by cutting through or punching out the remaining portions of transverse bars (4') between the punching grooves. Thus, separate spacers (1) are obtained, each having two longitudinal bars (2, 3).

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description

- DE2214532A1 [0003]

**PATENTKRAV**

1. Fremgangsmåde til fremstilling af afstandsstykker (1) til betonarmeringer og betonkonstruktioner, hvilken fremgangsmåde omfatter:

- 5 (a) tilvejebringelse af mindst fire parallelle langsgående stænger (6, 7, 7') i et plan, omfattende
- to perifere langsgående stænger (6); og
  - mindst ét stansespor, der består af et par indbyrdes tilstødende langsgående stænger (7, 7'), som er placeret mellem de perifere langsgående stænger (6);
- 10 (b) placering af tværgående stænger (4, 4') vinkelret på og/eller under de langsgående stænger og fastgørelse af de tværgående stænger til de langsgående stænger, således at der frembringes en gitterstruktur (5);
- (c) eventuelt afskæring af en eventuel del af de tværgående stænger (4), der rager ud over de perifere langsgående stænger;
- 15 (d) gennemskæring eller udstansning af delene af den tværgående stang (4) mellem de indbyrdes tilstødende langsgående stænger (7, 7') i stansesporet, eventuelt bortset fra to til fem af disse tværgående stangdele; således at der frembringes to eller flere langstrakte gitre, der eventuelt er forbundet til hinanden ved hjælp af to til fem uafbrudte tværgående stænger (4'); og
- 20 (e) bøjning af de to eller flere langstrakte gitre; i dette tilfælde frembringelse af to eller flere afstandsstykker (1) til betonarmeringer og/eller betonkonstruktioner, der hver omfatter to parallelle og identiske bugtende langsgående stænger (2, 3), som er forbundet med hinanden ved hjælp af tværgående stænger (4, 4'), som er vinkelrette på og lateralt forbundet med de langsgående stænger;
- 25 hvor de tværgående stænger ikke rager ud eller rager ud med højst 0,5 mm over de øverste og nederste langsgående stænger; og hvor afstandsstykkerne eventuelt er forbundet til hinanden ved hjælp af to til fem uafbrudte tværgående stænger (4').

2. Fremgangsmåde ifølge krav 1, hvor trin (a) omfatter udrulning og justering af mindst fire langsgående stænger (6, 7, 7') i et plan; og hvor trin (a), (b), (c) eller (d) endvidere omfatter skæring af de langsgående stænger til en ønsket længde.
- 5 3. Fremgangsmåde ifølge et hvilket som helst af kravene 1 til 2, hvor trin (e) endvidere omfatter drejning af hvert lige eller ulige gitter opnået i trin (d).
- 10 4. Fremgangsmåde ifølge et hvilket som helst af kravene 1 til 3, hvor de tværgående stænger (4) af afstandsstykkerne (1) ikke rager mere end 0,2 mm ud over de øverste og nederste langsgående stænger (2, 3).
- 15 5. Fremgangsmåde ifølge et hvilket som helst af kravene 1 til 4, hvor to eller flere langsgående stænger (6, 7, 7') har en forskellig diameter.
- 20 6. Fremgangsmåde ifølge et hvilket som helst af kravene 1 til 5, hvor afstanden mellem de indbyrdes tilstødende langsgående stænger (7, 7') på stansesporet er højst 10 mm.
- 25 7. Fremgangsmåde ifølge et hvilket som helst af kravene 1 til 6, hvor de tværgående stænger (4, 4') er placeret i en regelmæssig afstand fra hinanden.
- 30 8. Fremgangsmåde ifølge et hvilket som helst af kravene 1 til 7, hvor fremgangsmåden endvidere omfatter tilvejebringelse af én eller flere langsgående stænger i nævnte plan, idet de langsgående stænger er placeret mellem én af de perifere langsgående stænger (6) og stansesporet.
- 35 9. Fremgangsmåde ifølge et hvilket som helst af kravene 1 til 8, hvor de langsgående stænger (6, 7, 7', 8, 8') danner mindst to bånd, der hver indeholder to eller flere langsgående stænger, hvor
- hvert par af nabobånd er adskilt fra hinanden af et stansespor; og
  - mindst to af båndene har en forskellig bredde.

# DRAWINGS

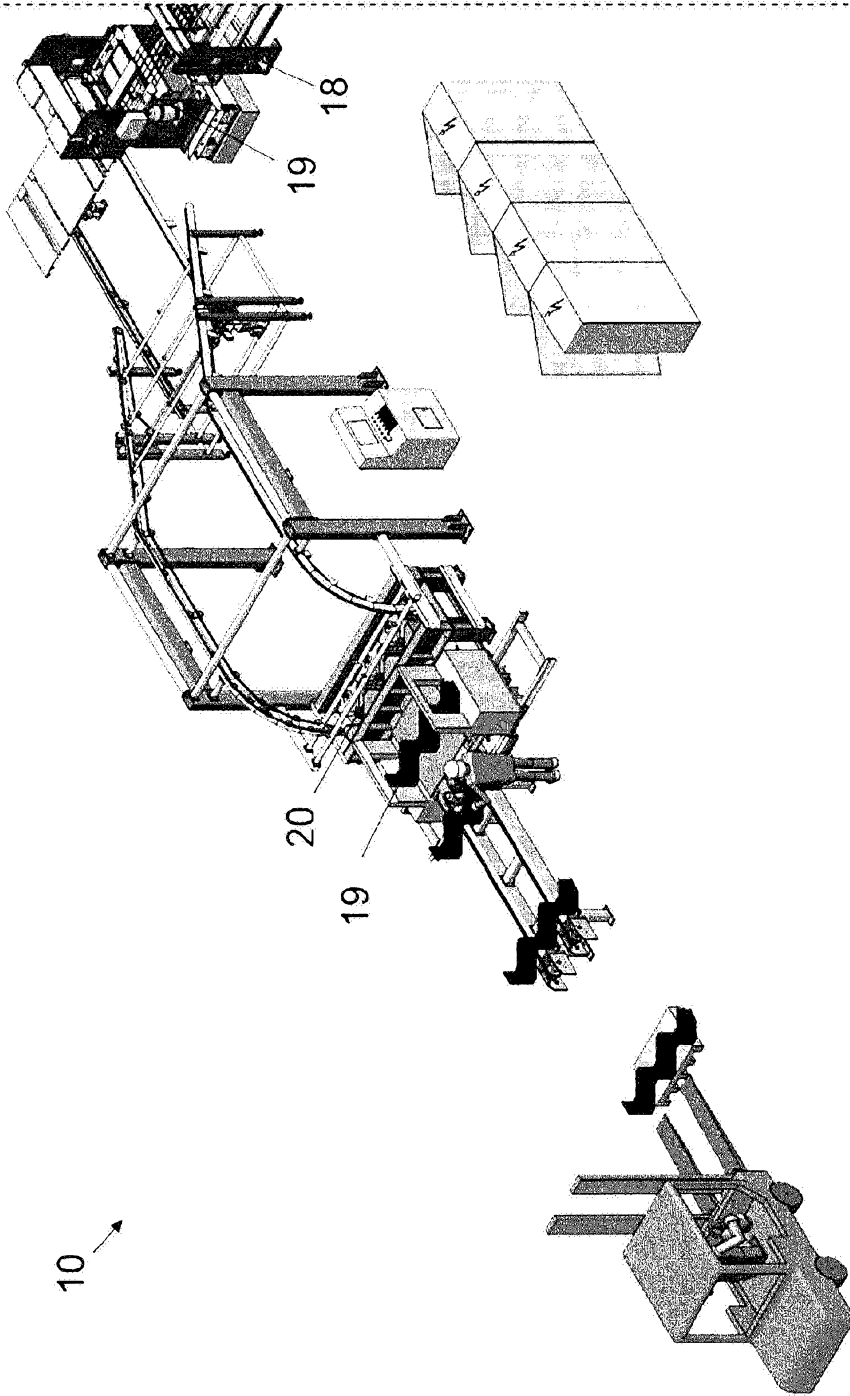


Fig. 1

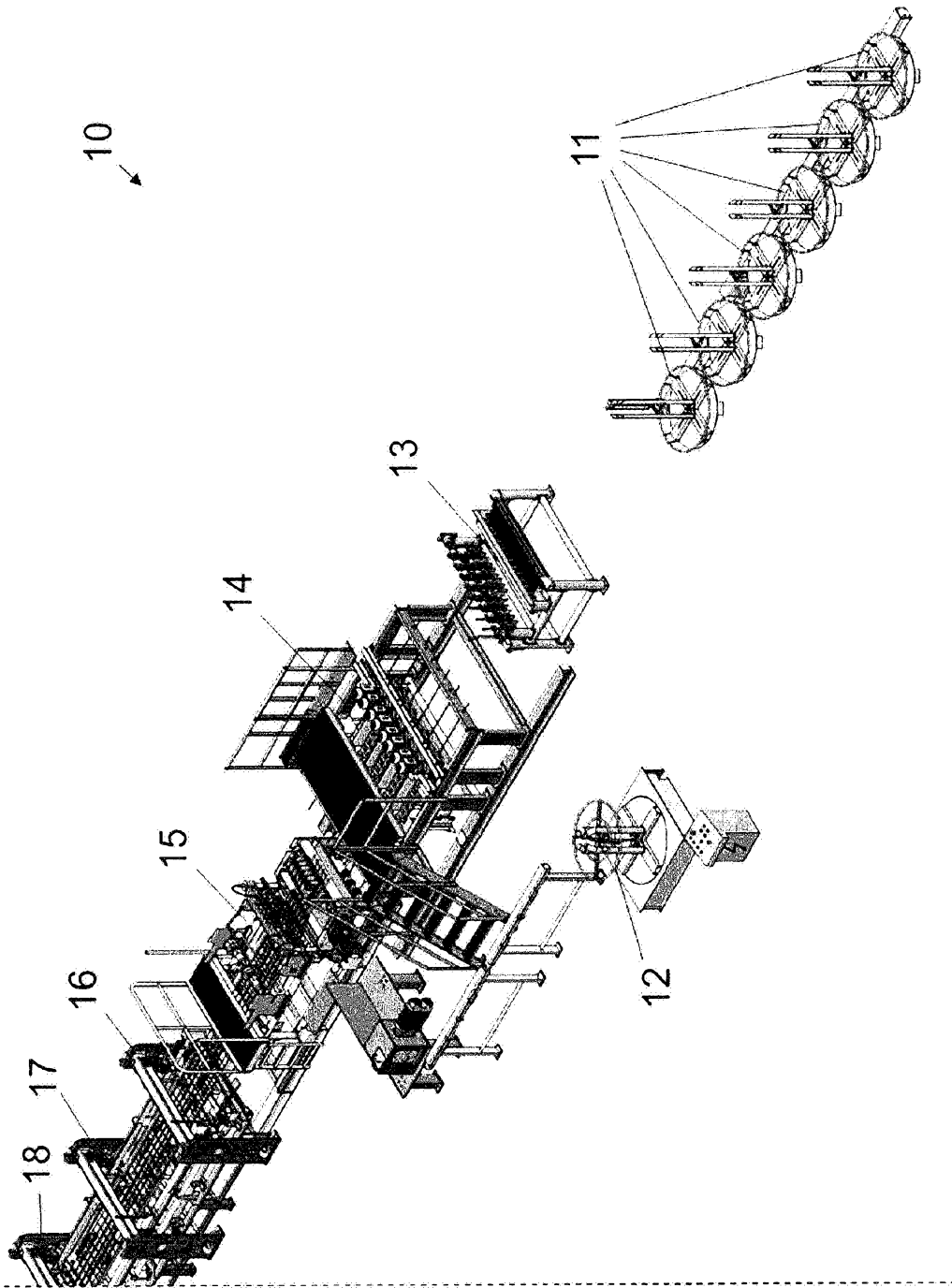


Fig. 1 (Continued)

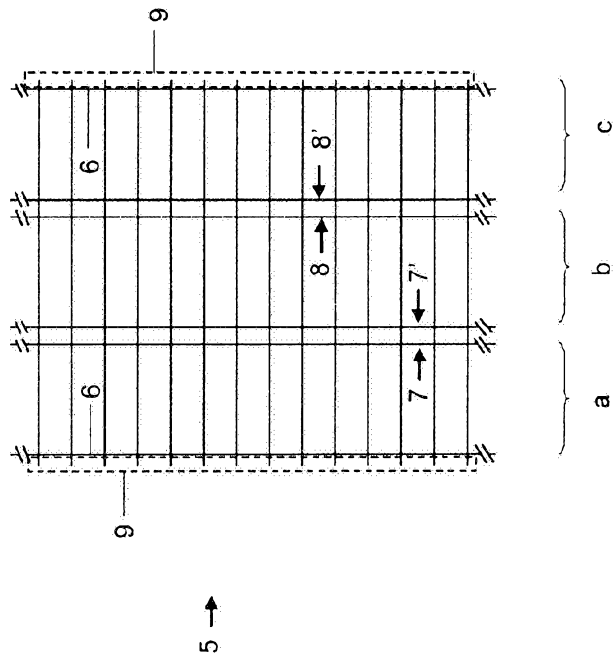


Fig. 2

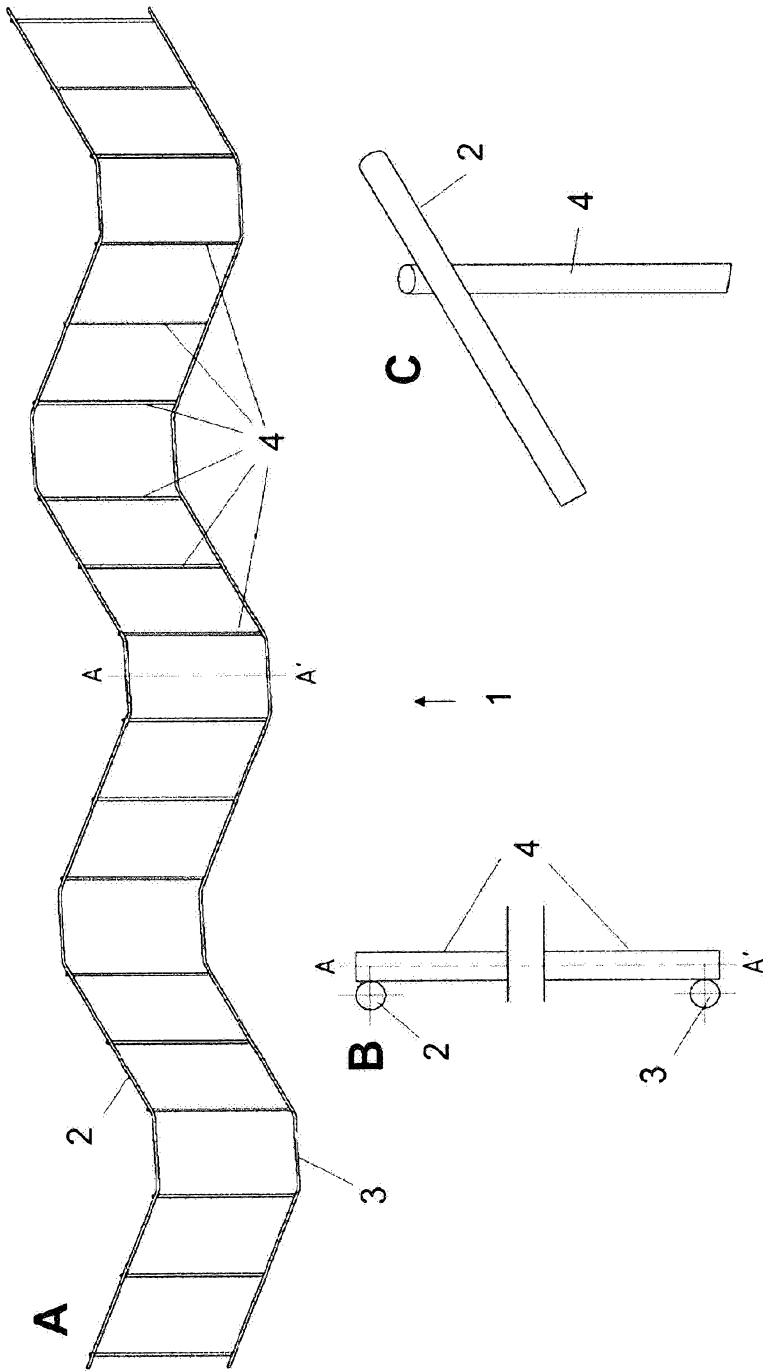


Fig. 3

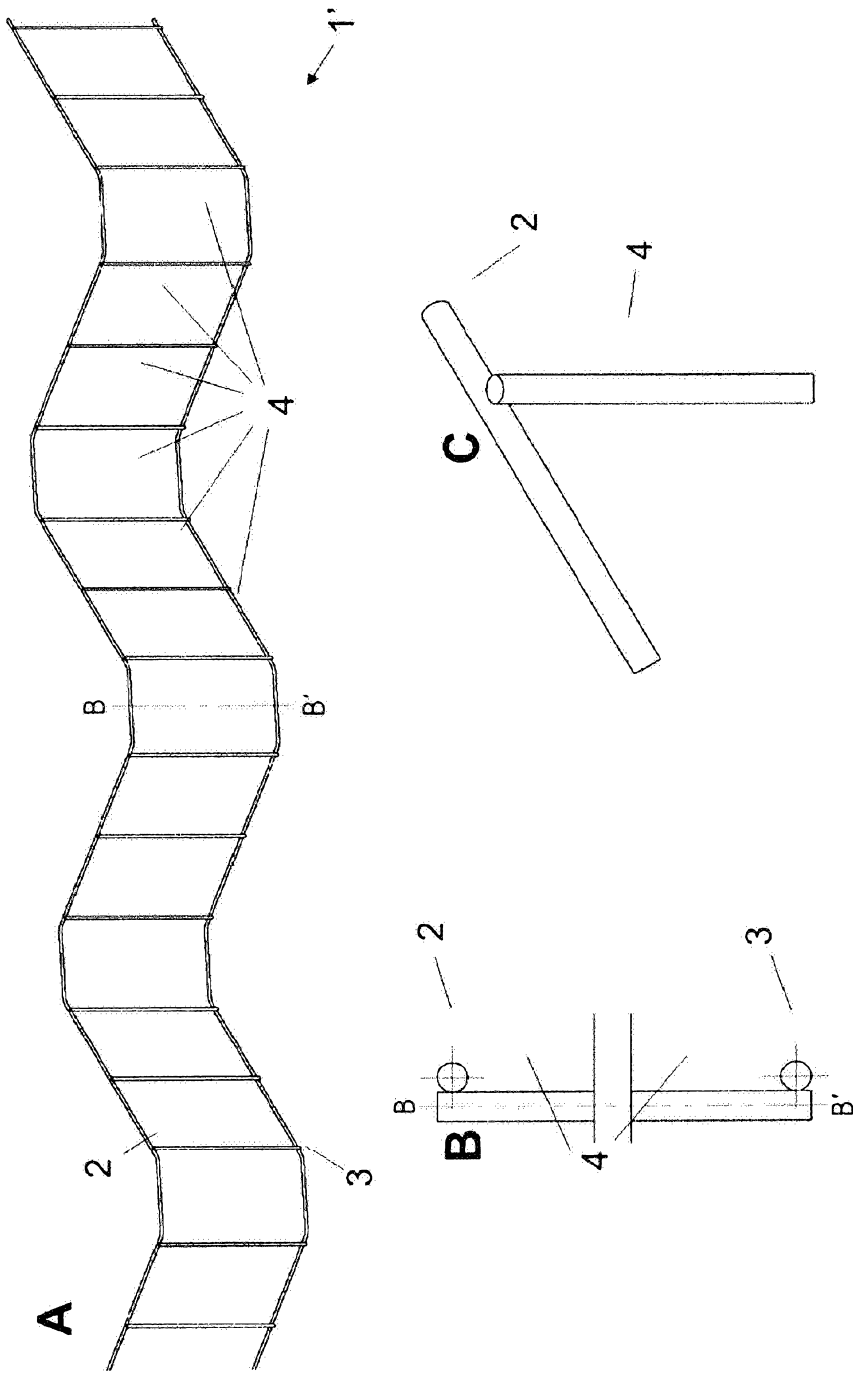


Fig. 4

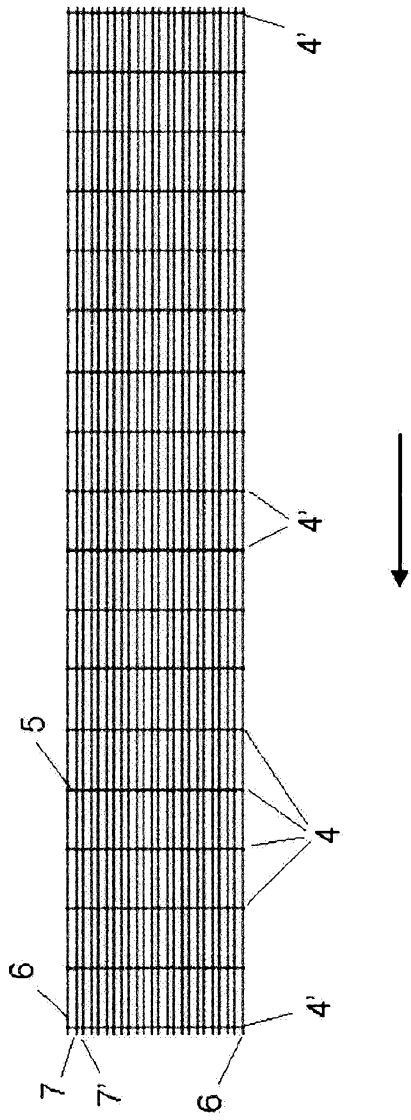


Fig. 5A

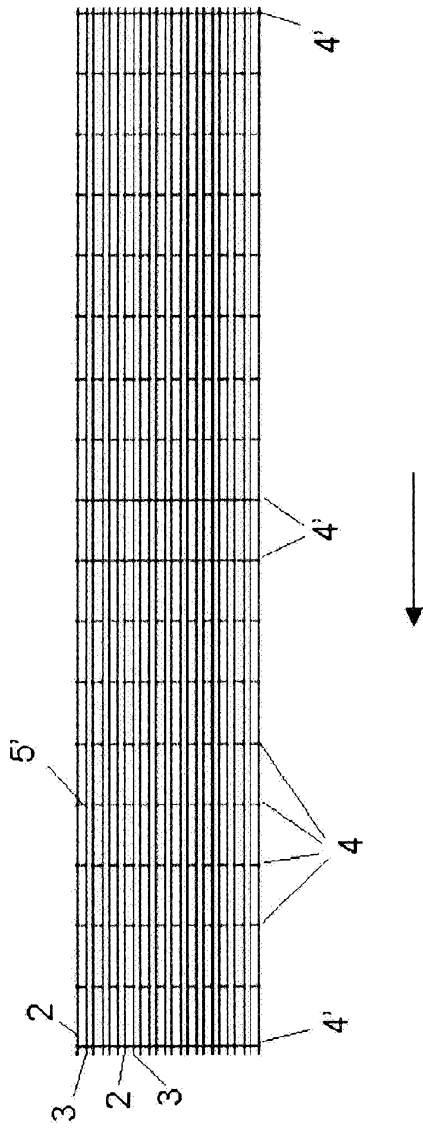


Fig. 5B

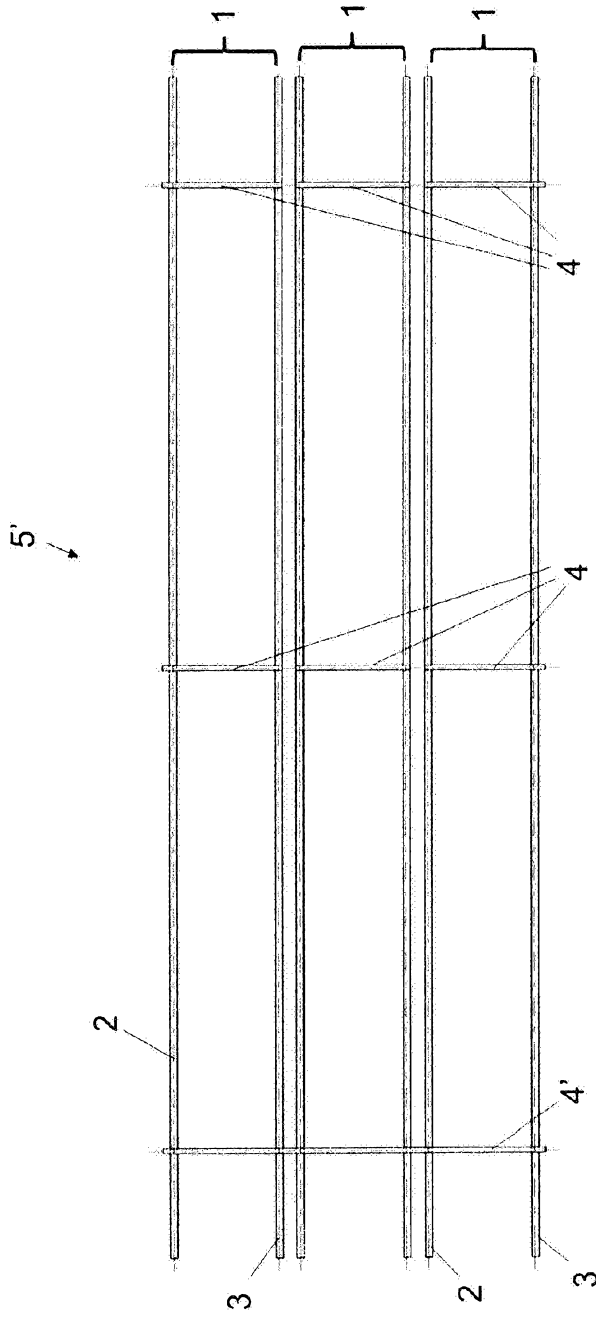


Fig. 5C