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(54) A WEFT STRAIGHTENER AND A METHOD FOR STRAIGHTENING A FABRIC WEB

SCHUSSFADENRICHTER UND VERFAHREN ZUM RICHTEN EINER STOFFBAHN

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Description

[0001] The present invention relates to weft straighteners for a fabric web manufacturing line. Further, the invention relates to methods for straightening a fabric web.

[0002] A fabric web in the meaning of the present invention shall in particular be understood as a fabric extending continuously in web running direction. In the following, the term fabric web and web are used as synonyms. In particular, a web shall be understood as a woven fabric being particularly made by weaving warp yarns and weft yarns. The direction in which the web is conveyed through the straighteners is designated as web running direction or as warp direction. The direction extending crosswise, in particular orthogonal, to the web running direction and defining together with the web running direction the plane in which the web extends is designated as cross direction or as weft direction. The web running direction is particularly defined by the direction in which the warp yarns of the web extend.

[0003] Upon processing the web, such as weaving or knitting yarns into a web or coloring the web, the yarns forming the web become structurally warped and irregularly stressed leading to undesirable characteristics of the web. For instance, the weft yarns of a woven fabric often deviates from a predetermined extension in that they extend inclined compared to a theoretical weft direction extending orthogonal to the warp yarns and curved instead of straight. The curved extension of the weft yarns is also known as "bow error" while the inclined extension is known as "skew errors". In order to correct the bow errors in a web, it is known to process the web by bow drum arrangements. In a bow drum arrangement, a web is conveyed over so-called "bow drums" having a curved shape so as to correct the bow errors by reducing the curvature of the weft yarns. In order to correct the skew errors, the web is conveyed over skew drums being pivotably mounted about a pivot axis. Such devises are designated as skew drum arrangements. Devices comprising bow and skew drums are designated as weft straighteners. One such weft straightener is known from DE 1 906 801 A1. Therein, two skew drums and two bow drums are arranged in that the web is guided in web running direction along a predetermined path over a first bow drum, a first skew drum, a fixedly mounted fixed drum, a second skew drum and a second bow drum. Further examples of weft straighteners are known from DE 16 35 138 A1, GB 1 358 868 A and CH 403 696 A.

[0004] However, it has been found that the correction of bow errors and weft errors which can be achieved by the use of known weft straighteners, such as the one proposed in DE 1 906 801 (A1), is not sufficient. In particular, it has been found that the yarns extending crosswise the web running direction, in particular the weft yarns, of a web having been processed with the known weft straighteners, do not extend perfectly straight but extend buckled at about one third of the web extension crosswise the web running direction. In particular, it has been found that after applying finishing processes, such as washing, to fabrics being processed with known weft straighteners, the fabrics are warped at about one third of the web extension crosswise the web running direction. This warping is also known as earing effect.

[0005] It is therefore an object of the present invention to overcome disadvantages of the prior art, in particular to provide a weft straightener and a method for straightening a fabric web, allowing increased bow correction, skew correction and/or prevention of warpage of the fabric, in particular warpage upon finishing processes.

[0006] The problem is solved by the independent claims.

[0007] According to the invention a bow drum arrangement is provided in the weft straightener for a fabric web manufacturing line. The bow drum arrangement can be suitable for reducing the curvature of yarns in a fabric web, in particular of weft yarns in a woven fabric web. The weft straightener comprises a bow drum arrangement and a skew drum arrangement. A fabric manufacturing line can comprise a weft straightener and one or more of apparatuses commonly used in a fabric manufacturing line, such as a weaving apparatus, a dyeing apparatus, a sizing apparatus and a sizing apparatus.

[0008] The bow drum arrangement comprises at least two bow drums. The bow drums can be suitable for deflecting a fabric web. Therefore, the bow drum can extend along a longitudinal axis about at least 1 meter, 2 meter, 3 meter or 4 meter. The bow drum can be rotatably mounted about a rotation axis.

[0009] The bow drum arrangement can comprise a plurality of fixed drums. A fixed drum can in particular be understood as a drum being mounted in a fixed orientation relative to the rotation axis.

[0010] According to to an embodiment, at least one bow drum is located in web running direction in between two of the plurality of fixed drums in that it receives the fabric web from one fixed drum and delivers the fabric web to one fixed drum. In particular, the at least one bow drum is located in that it directly receives the fabric web from a fixed drum and directly delivers it to a fixed drum. In other words, the fabric web extends straight from an upwards mounted fixed drum to the at least one bow drum and straight from the at least one bow drum to a downstream mounted fixed drum. In yet other words, in web running direction before and behind the at least one bow drum, the fabric web is only reflected by other bow drums or by skew drums after being reflected by a fixed drum. It shall be clear that, within the meaning of the invention, the terms "receiving" and "delivering" only serve to describe how drums are arranged so as to receive and the deliver the fabric during operation of the drum arrangement. Of course, the drum arrangement shall also be protected in a passive status of the drum arrangement. Thus, the first aspect of the invention can alternatively be formulated in that the plurality of fixed drums are mounted upwards and downwards the at least

one bow drum along a predetermined guiding path for the fabric web in that the guiding path extends in web running direction from the upwards mounted fixed drum directly to the at least one bow drum and from the at least one bow drum directly to the downwards mounted fixed drum. Within the meaning of the present invention, the mounting of a drum upwards another drum along a predetermined guiding path means that a web being guided in a predetermined web running direction through the respective arrangement passes the upwards mounted drum before the drum compared to which it is mounted upwards. Respectively, mounted downwards means that the web passes the downwards mounted drum after passing the drum compared to which it is mounted downwards.

[0011] A predetermined guiding path within the meaning of a present invention is the path along which a web is intended to be guided through the respective straightener. In particular, the predetermined guiding path shall not encompass any possible guiding path but only the one which is intended to be used for guiding the web through the respective straightener.

[0012] The web running direction is the direction in which the web is intended to run through the respective straightener. In one embodiment, the web running direction can be identified by the presence of a measuring device being located at the end of the straightener. A direct extension of the guiding path from one drum to another drum can be understood in that the guiding path extends straight away from the one drum to the other drum. In particular, the section of the guiding path extending straight from one drum to the other drum can be free from additional drums deflecting a web in this guiding section.

[0013] The inventors of the present invention have surprisingly found that the undesired earing effect occurring in webs during finishing processes, such as washing, is caused by the commonly known practice to guide the web directly from bow drums to skew drums or vice versa. This can be explained by the superposition of the strain profile of the web in cross direction caused by the bow drum with the strain profile of the web in cross direction caused by the skew drum. The curved course of the bow drum causes a strain profile according to which the strain in the web increases or decreases from the middle of the web towards end sections of the web in cross direction. Thereby, web sections being equally distanced from the middle of the web are subjected to substantially the same strain. Contrary thereto, the inclined skew drum causes the strain to continuously increase or decrease from one end section of the web to the other end section in cross direction. The superposition of these two different strain profiles leads to an irregular overall strain profile which causes the undesired earing effect. The inventors have also found that a web being directly guided from a bow drum to a skew drum or vice versa comprises a buckled course of the yarns extending in cross direction which usually occurs about one third of the web extension in cross direction. This buckled course impairs the visual appearance of the fabric web, its strength and its tendency to warp during finishing processes. It has surprisingly been found that also the buckled course of the yarns can be avoided or at least minimized upon the use of the inventive weft straightener.

[0014] Because of the above identified problems of guiding the web directly from a bow drum to a skew drum or vice versa, it is a general concept of the invention to separate the step of reducing the curvature of the yarns by bow drums and the step of adjusting the inclination of yarns in a web by skew drums.

[0015] Reducing the curvature of yarns in a web can be understood as straightening a curved yarn. Thereby, the curvature of the yarn can be reduced or nullified so that the yarn extends particularly completely straight. The bow drum arrangement relates to a bow drum arrangement for reducing the curvature of weft yarns in a woven fabric web. The woven fabric web can comprise warp yarns and weft yarns. Due to the weaving and/or subsequent processes, such as sanforizing or dying, the weft yarns of a fabric usually extend curved in the fabric. Such curvature can impair the visual appearance and/or the strength of the fabric. By reducing the curvature of the yarns, the bow drum arrangement can increase the visual appearance and/or the strength of the fabric upon reducing the curvature of the weft yarns.

[0016] The bow drum can have a cylindrical shape. The bow drum can be curved, in particular extend along a curved axis. The bow drum can comprise a cylindrical surface for guiding the web. The cylindrical surface can extend along a curved cylindrical axis. The bow drum can extend in cross direction from one end section over a vertex to the other end section. The vertex can be located in the middle of the at least one bow drum in cross direction. The at least one bow drum can comprise a constant radius of curvature along its extension in cross direction. The at least one bow drum can be curved in a circular segment manner.

[0017] The end sections of the bow drum can be connected with rotary bearings. The rotation axis can extend as a straight line. The rotation axis can be defined by a line extending from one end section, in particular from a rotary bearing, to the opposing end section, in particular a second rotary bearing, of the bow drum. The bow drum arrangement can comprise a drive, in particular a motor for rotating the bow drum about the rotational axis. Due to the curvature of the bow drum, the curved bow axis can be spaced from the rotational axis. The space between the curved bow axis and the rotational axis can decrease from the vertex of the at least one bow drum to the end sections of the bow drum. Due to the curved extension of the bow drum, the length of the guiding path between the bow drum and the plurality of fixed drums can be different for the middle section, in particular the vertex, and for the end sections of the bow drum. For instance, if the bow drum is oriented in that its convex side faces one of the plurality of fixed drums, the length

of the guiding path for the middle sections of the web will be shorter than the length of the guiding path for the end sections of the web. In the opposite case, when the concave side of the bow drum faces one of the plurality of fixed drums, the length of the guiding path of the middle section of the web between these two drums will be longer than the length of the guiding path for the end sections of the web. In the first case, the strain in end sections will be higher while in the second case, the strain in the middle section will be higher. Thus, upon rotating the bow drum about its rotational axis, the strain distribution in cross direction can be changed.

[0018] The fixed drums can have a cylindrical shape. The fixed drums extend rectilinear, in other words are uncurved. The fixed drums can be rotatably mounted or can be fixedly mounted with regard to the circumferential direction around the longitudinal axis. Rotatably mounting a drum about a rotational axis shall be understood in that the rotation axis extends lengthwise, in particular parallel to, the longitudinal extension of the respective drum. In the case of a bow drum, the rotation axis can extend parallel to a straight line extending from one end of the bow drum to another end of the bow drum. A drum being pivotably mounted about a pivot axis can be understood in that the pivot axis extends crosswise, in particular orthogonal, to the longitudinal extension of the respective drum. In particular in case of a skew drum, the pivot axis can extend orthogonal to the longitudinal axis of the skew drum.

[0019] The two fixed drums between which at least one bow drum is mounted are mounted in a fixed orientation relative to the rotation axis or the bow axis of the bow drum. The fixed orientation can be understood in that the fixed drums extend along a longitudinal axis having a fixed orientation relative to the rotation axis or the bow axis. The orientation of the longitudinal axis can be parallel to the rotation axis.

[0020] The fixed orientation shall be understood in that the plurality of fixed drums are not pivotably mounted. In particular, the plurality of fixed drums are fixedly mounted on a support structure of the bow drum arrangement. The fixed mounting in a fixed orientation does not necessarily mean that the fixed drums cannot be transversely moved. As long as the fixed drums cannot be pivoted, such transvers movability can be allowed. However, in a preferred embodiment, the plurality of fixed drums are mounted in that they have maximally one degree of freedom of movement, in particular one rotational degree of freedom around the longitudinal axis of the plurality of fixed drums.

[0021] Compared to the known bow drum arrangements, the fixed orientation of the fixed drums saves costs for the pivotable mounting. Further, unintended pivoting of the fixed drums due to forces acting on the fixed drums, such as by the tensioned web, can be avoided. Thereby, the bow drum arrangement ensures that a predetermined strain distribution along the cross direction of the web can be maintained during operation. Further, energy which would be necessary to keep the orientation of pivotably mounted fixed drums constant against forces acting on the pivotably mounted drums can be saved so that also the energy consumption of the bow drum arrangement can be reduced.

[0022] In one embodiment, the plurality of fixed drums extends along longitudinal axis extending parallel to the rotation axis. In a less preferred embodiment, only one of the plurality of fixed drums extend along a longitudinal axis extending parallel to the rotation axis. The inventors of the present invention have surprisingly found that guiding the web directly from a fixed drum extending parallel to the rotation axis to the bow drum and from the bow drum directly to a second fixed drum with a longitudinal axis extending parallel to the rotation axis helps to avoid the undesired earing effect. In particular, it has surprisingly been found that even if the web is subsequently guided through a skew drum arrangement, the earing effect of the fabric can still be avoided or at least be reduced. This can be explained in that the separation of bow straightening and skew straightening avoids the superposition of the strain distribution caused by the bow drums and the strain distribution caused by the skew drums and thereby avoids the earing effect.

[0023] According to the invention, the bow drum arrangement of the weft straightener comprises at least two bow drums, particularly at least three bow drums. According to an embodiment, each of the bow drums can be located in web running direction upwards one of the plurality of fixed drums in that it delivers the fabric web to a fixed drum. Additionally or alternatively, each of the at least two bow drums is located in web running direction downwards one of the plurality of fixed drums in that it receives the fabric web from a fixed drum. Alternatively, this embodiment could be formulated in that the bow drum arrangement of the weft straightener comprises at least two bow drums, particularly at least three bow drums, being mounted in an alternating manner with the plurality of fixed drums in particular in that each of the at plurality of fixed drums is mounted upwards a respective bow drum along the guiding path in that the guiding path extends in web running direction from each upwards mounted fixed drum directly to a respective bow drum and/or in that each of the plurality of fixed drums is mounted downwards a respective bow drum along the guiding path in that the guiding path extends in web running direction from each bow drum directly to a respective fixed drum. In the context of the present invention, receiving and delivering the fabric web from one drum to or from another drum shall in particular mean that the fabric web directly extends from one drum to the other drum in particular without being additionally deflected in between these drums by additional drums

[0024] Additionally or alternatively, the at least two bow drums and the plurality of fixed drums are arranged in that the fabric-web is deflected in a sinus like manner. In the following, it is explained by way of example, how such deflection in a sinus like manner can be achieved.

[0025] The plurality of fixed drums can be arranged in

that their longitudinal axes define a particularly flat fixed drum plane. The fixed drum plane can extend in any orientation. However, it is preferred that the fixed drum plane extends in vertical direction. The plurality of fixed drums can be spaced from each other by at least 0.75 times, in particular at least 1.0 times, the diameter of the at least one bow drums and/or of the plurality of fixed drums. When indicating a space between two drums, this space shall be understood as the space between the guiding surfaces of the drums. Alternatively, the space can be indicated between the longitudinal axes of the respective drums. In such case, the space can be increased by 0.75, in particular by 1.0, of the respective drum diameter. For instance, the space between the longitudinal axes of the at least two fixed drums can be at least 1.5 times, in particular at least 2 times, the diameter of the at least one bow drum and/or the plurality fixed drums. Each of the plurality of fixed drums can extend parallel to each other. The space between each of plurality of fixed drums, in particularly between at least three fixed drums, can be the same.

[0026] At least one bow drum can be spaced from the fixed drum plane. The space between the bow drum and the fixed drum plane can be measured by the distance between the rotation axis of the at least one bow drum and the fixed drum plane. The space between the rotation axis and the fixed drum plane can be at least two times, in particular at least three times, the diameter of the bow drum and/or of each of the plurality of fixed drums. Additionally or alternatively, the rotation axis of the bow drum can be spaced from at least one of the plurality of fixed drums in the direction in which the fixed drum plane extends. In a preferred embodiment, this direction is the vertical direction. In this direction, the rotational axis can be spaced from the longitudinal axis of the upwards and/or downwards mounted fixed drum by at least 0.25, 0.5 or 0.75 times the diameter of the fixed drum and/or of the bow drum. In particular, the rotation axis of the bow drum can be spaced in equal distance from the longitudinal axis of the upwards and downwards mounted fixed drum in this direction.

[0027] The rotation axis of the at least two, in particular at least three, bow drums can extend parallel to each other. In particular, the rotation axis of the at least two bow drums can define an in particular flat bow drum plane. The bow drum plane can extend in any orientation. However, preferably the bow drum plane extends in vertical direction. The bow drum plane can be spaced from the fixed drum plane. In particular, the bow drum plane and the fixed drum plane are spaced from each other by at least 1.0, 1.5 or 2.0 times the diameter of the at least two bow drums and/or the plurality of fixed drums. In particular, the bow drum plane and the fixed drum plane can extend parallel to each other. In particular, the space between the bow drums within the bow drum plane and the space between the fixed drums within the fixed drum plane can be the same. In particular, the bow drums can be spaced from upwards and/or downwards mounted fixed drums in the direction of the bow drum plane by the half of the space between two bow drums and/or between two fixed drums.

[0028] In one embodiment, at least one bow drum is mounted between the plurality of fixed drums in that the bow drum deflects the guiding path by at least 90°, particularly at least 120°, 150° or 180°, between the plurality of fixed drums. In particular, the bow drum and the plurality of fixed drums are arranged in that the guiding path between a bow drum and a fixed drum, in particular between each bow drum and between each fixed drum, extends substantially horizontally. Substantially horizontally can encompass an inclination angle of +/- 30°, 25°, 20°, 15°, 10°, 5° or 3° relative to a horizontal plane. In particular, the bow drum and/or the plurality of two fixed drums are arranged in that a fabric web being deflected through the bow drum arrangement, in particular passing along the predetermined guiding path, contacts the guiding surface, in particular a cylindrical surface, of the bow drum and/or of the plurality of fixed drums along at least 90°, 120°, 150° or 180° of their extension in circumferential direction of the respective axis.

[0029] In particular with the above arrangements/locations of the at least two or three bow drums and the plurality of fixed drums, a deflection of the fabric web a sinus like manner can be achieved.

[0030] According to the invention, a skew drum arrangement is provided in the weft straightener for a fabric web manufacturing line. The skew drum arrangement can be suitable for adjusting the inclination of yarns in a fabric web, in particular of weft yarns in a woven fabric web.

[0031] The skew drum arrangement comprises at least two skew drums. The skew drum can be pivotably mounted about a pivot axis. Further, the skew drum arrangement can comprise a plurality of fixed drums, in particular at least two fixed drums. According to an embodiment, at least one skew drum is located in web running direction in between two of the plurality of fixed drums in that it receives the fabric web from one fixed drum and delivers the fabric web to one fixed drum. As explained above, the inventive straighteners shall also be protected in passive state. Thus, this embodiment of the invention could alternatively be described in that plurality of fixed drums can be mounted upwards and downwards of at least one skew drum along a predetermined guiding path for the web in that the guiding path extends in web running direction from the upwards mounted fixed drum directly to the at least one skew drum and from the at least one skew drum directly to the downwards mounted fixed drum. The plurality of fixed drums can extend in a rectilinear manner.

[0032] The features previously described with regard to the mounting position of the bow drum and the fixed drums, the space between the drums, the extension along drum planes and other features can be also realized within this embodiment of the invention with regard to the skew drums and the plurality of fixed drums. The

yarns extending crosswise the web running direction, in particular the weft yarns, of a fabric web, in particular of a woven fabric web, can extend inclined to the cross direction, in particular to the weft direction. Such inclination can be caused for instance by the weaving process of the woven fabric web, by sanforizing processes or by dying processes. The inclination angle can vary from fabric to fabric or within the extension of a fabric in web running direction. Depending on the intended use of the web, it can be desirable to totally compensate the inclinations so that the crosswise extending yarns extend parallel to the cross direction. However, as will be described below, it can also be desirable to adjust the inclination of the yarns to a desired inclination angle relative to the cross direction in order to avoid warpage of the web. One way or another, the inventors of the present invention have found that the commonly used weft straighteners do not lead to satisfactory results with regard to the adjustment of a desired inclination. As previously discussed, this can be explained by the superposition of the strain distribution in cross direction caused by the bow drums and by the skew drums. The inventors have found that mounting fixed drums in particular extending in a rectilinear manner directly upwards and downwards the skew drum increases the precision with which the inclination of the yarns extending crosswise the web running direction can be increased.

[0033] Adjusting the inclination of yarns in a web can be understood as adjusting the inclination of the yarns extending crosswise the web running direction. In particular, adjusting can be understood as increasing or decreasing the inclination of the yarns. Additionally or alternatively, adjusting can be understood as providing a constant inclination along the cross direction. A constant inclination can in particular be understood as an extension of the yarns in cross direction without bucklings.

[0034] The skew drum can extend in a rectilinear manner. The skew drum can be cylindrically shaped. The skew drum can comprise a cylindrical guiding surface extending along a straight skew drum axis. The skew drum axis can be inclined relative to the axis of the plurality of fixed drums. In particular, the skew drum axis can be pivoted - compared to a parallel course with the axis of the fixed drums - about a skew-drum angle away or towards the axis of the fixed drums in particular within a horizontal plane. In a less preferred embodiment, the skew drum axis can be fixedly mounted - in other words are not pivotable - as long as they are mounted in an inclined position relative to the fixed drums.

[0035] Pivotably mounted can be understood in that the orientation of the skew drum can be changed upon pivoting the skew drum about the pivot axis. The pivot axis can extend in that upon pivoting the skew drum, the skew drum can be pivoted towards or away from the at least two fixed drums. Depending on whether the skew drum is pivoted towards or away from the at least two fixed drums, an initial inclination of the yarns extending in cross direction can be increased or decreased. In particular, the skew drum can be pivoted about a pivot axis in that the skew drum extend in a pivot angle relative to a parallel orientation with a longitudinal axis of the fixed drums. The greater the pivot angle becomes, the stronger the inclination of the yarns extending crosswise the running direction can be increased or decreased.

[0036] The pivot axis can extend crosswise the longitudinal axis of the fixed drums. In particular, the pivot axis extends orthogonal to at least one, two or three of the plurality of fixed drums. Most preferably, the pivot axis extends in vertical direction. The at least two fixed drums can be designed, located and/or mounted relative to the skew drums as described for the fixed drums relative to the bow drums.

[0037] In order to increase the accuracy of adjusting the inclination of the yarns extending crosswise the web running direction, it is advantageous when the at least two fixed drums extend in a rectilinear manner. Rectilinear can be understood in that the fixed drums extend in the form of a straight cylinder. Alternatively to the extension in a rectilinear manner, it could also be said that the fixed drums shall have a cylindrical shape extending along a straight, in particular perfectly straight, longitudinal axis. In particular, it could be said, that the fixed drums are not curved.

[0038] In particular, the fixed drum delivering the fabric web to at least one skew drum, in other words the upwards mounted fixed drum, and the fixed drum receiving the fabric web from at least one skew drum, in other words the downwards mounted fixed drum, can comprise a cylindrical guiding surface extending along a straight longitudinal axis. The guiding surface of the downwards mounted fixed drum can provide a straight receiving section for the web being received from the skew drum. The guiding surface of the upwards mounted fixed drum can provide a straight overhanding section for the web being handed over to the skew drum. A rectilinear extension of the plurality of fixed drums, in particular of the upwards and downwards mounted fixed drums, ensures that the strain distribution of the web in cross direction is not superimposed by strain distributions caused by drums being mounted directly upwards and/or downwards the skew drum.

[0039] According to the invention, the skew drum arrangement comprises at least two skew drums, particularly at least three skew drums. In an embodiment, each skew drum can be located in web running direction upwards one of the plurality of fixed drums in that it delivers the fabric web to a fixed drum. Additionally or alternatively, each of the at least two skew drums is located in web running direction downwards one of the plurality of fixed drums in that it receives the fabric web from a fixed drum. Alternatively, this embodiment could be formulated in that the weft straightener comprises at least two skew drums, particularly at least three skew drums, being mounted in an alternating manner with the plurality of fixed drums in particular in that each of the at plurality of fixed drums is mounted upwards a respective skew drum along the

guiding path in that the guiding path extends in web running direction from each upwards mounted fixed drum directly to a respective skew drum and/or in that each of the plurality of fixed drums is mounted downwards a respective skew drum along the guiding path in that the guiding path extends in web running direction from each skew drum directly to a respective fixed drum.

[0040] The embodiments and features described above with regard to the arrangement of at least two bow drums in an alternating manner with the plurality of fixed drums can also be realized with regard to the alternation of the at least two skew drums and the plurality of fixed drums. In particular, the at least two skew drums and the plurality of fixed drums can be arranged in that the fabric web is deflected in a sinus like manner. Such arrangement between skew drums and fixed drums can be achieved as described with respect to bow drums and fixed drums

[0041] The spacing and/or the arrangement of the at least two fixed drums of the skew drum arrangement can be realized as described for the bow drum arrangement. Additionally or alternatively, the spacing of the plurality of skew drums from the fixed drum plane can be realized as it was described for the bow drum arrangement. Additionally or alternatively, the at least two, in particular at least three, skew drums can be spaced from each other and/or arranged in a skew drum plane as it was described for the bow drums of the bow drum arrangement. When the space of a skew drum axis to a longitudinal axis of a fixed drum is concerned, this space shall relate to a in particular theoretical position of the skew drum in which the skew drum axis extend parallel to the longitudinal axis of the fixed drums.

[0042] The at least two, in particular at least three, skew drums can be pivotably mounted in a pivot frame. The at least two skew drums can be mounted in a fixed orientation within the pivot frame. The pivot frame can be pivotably mounted so as to pivot the skew drums. The at least two skew drums can extend parallel to each other. The at least two skew drums can be pivotably mounted by a common pivot operator such as a pivot frame.

[0043] The skew drum arrangement can comprise a drive for pivoting the at least two or at least three skew drums about their pivot axis. In the case of at least two or at least three skew drums, the skew drums can be pivotably mounted about a common pivot axis. The pivot axis can extend in vertical direction.

[0044] The invention relates to a weft straightener comprising the previously described bow drum arrangement and the previously described skew drum arrangement. The bow drum arrangement can be mounted in web running direction upwards or downwards the skew drum arrangement. However, it is preferred to mount the bow drum arrangement in web running direction upwards the skew drum arrangement. The at least two bow drums, the plurality of fixed drums of the bow drum arrangement, the at least two skew drums and the plurality of fixed drums of the skew drum arrangement can all be mounted on a common frame structure. The plurality of fixed drums of the bow drum arrangement can be mounted in a bow drum arrangement fixed drum plane. The plurality of fixed drums of the skew drum arrangement can be mounted in a skew drum arrangement fixed drum plane. The bow drum arrangement fixed drum plane and the skew drum arrangement fixed drum plane can be spaced from each other in particular in horizontal direction and/or can extend substantially parallel to each other. Substantially parallel can encompass a deviation of a parallel alignment of 30°, 20°, 10°, 5°,.3° or 1°. In embodiments with at least two bow drums, the at least two bow drums can be arranged in a bow drum plane. In embodiments with at least two skew drums, the at least two skew drums can be arranged in skew drum planes. The bow drum plane and the skew drum plane can be spaced from each other in particular in horizontal direction and/or can extend substantially parallel to each other.

[0045] The at least two bow drums and the plurality of fixed drums of the bow drum arrangement can be arranged in that the guiding path between at least one bow drum and at least one skew drum extends substantially in horizontal direction while the at least two bow drums and the at least two fixed drums are spaced from each other in vertical direction. The extension of the guiding path and the space between the at least two skew drums and the at least two fixed drums can be realized in the same manner.

[0046] The weft straightener comprises at least two, preferably three, fixed drum/s being mounted between the bow drum arrangement and the skew drum arrangement along the guiding path. In particular the fixed drums can extend in a rectilinear manner and/or can be mounted in a fixed orientation relative to the rotation axis of the bow drums and/or of the skew drums. In particular, the fixed drums can extend along a longitudinal axis extending parallel to the rotation axis of the bow drum and/or to the longitudinal axis of the fixed drums of the bow drum arrangement and/or of the skew drum arrangement. It has been found that the implementation of fixed drums between the bow drum arrangement and the skew drum arrangement can balance the strain distribution caused by the bow drum arrangement and/or the skew drum arrangement in cross direction of the web. Therefore, these fixed drums can also be called balancing drums. Thereby, it can be ensured that the web facing the downwards arranged drum arrangement, for instance the skew drum arrangement, is less impaired by the strain distribution in cross direction caused by the previous drum arrangement, such as the bow drum arrangement. It has been found that increasing the length of the path along the balancing drums and/or the number of the balancing drums increases the uniformity of the strain in the web in cross direction. Therefore, it has been found particularly advantageous to implement at least two balancing drums being spaced from each other by at least three times, five times or seven times the diameter of the at least one bow drum or the at least one skew drum. There-

by a guiding path between these two balancing drums with the length of at least the distance between these drums can be provided, thereby increasing the uniformity of the stress in cross direction in the web facing the downwards drum arrangement, such as the skew drum arrangement. In order to further increase this effect, it has been found advantageous to additionally or alternatively space at least one balancing drum by at least 3 times or 4 times the diameter of the bow drum or the skew drum from an upwards mounted bow drum and/or skew drum. Additionally or/alternatively it has been found advantageous to space one of the at least two balancing drums by at least 2 times, 4 times or 6 times the diameter of the bow drum or the skew drum from a downwards mounted bow drum and/or skew drum.

[0047] The weft straightener can be used for a fabric web manufacturing line. The weft straightener can be suitable for reducing the curvature of yarns in a web and for adjusting the inclination of the yarns in the web, in particular of weft yarns in a woven fabric. The weft straightener comprises a bow drum arrangement comprising at least two bow drums. The bow drum arrangement can be suitable for reducing the curvature of the yarns. The at least two bow drums can be rotatably mounted about a rotation axis. The bow drum arrangement can be designed according to embodiments described above. Additionally, the weft straightener comprises a skew drum arrangement comprising at least two skew drums. The skew drum arrangement can be suitable for adjusting the inclination of the yarns. Each of the at least two skew drums can be pivotably mounted about a pivot axis. The skew drum arrangement can be designed according to any of the embodiments described above.

[0048] According to the invention the bow drum arrangement and the skew drum arrangement are in web running direction successively arranged in that the fabric-web is first deflected by the at least two bow drums and subsequently by the least two skew drums or vice versa. Alternatively, the invention could be formulated in that the bow drum arrangement and the skew drum arrangement are arranged successively in that a predetermined guiding path for the fabric web passes in web running direction first the at least two bow drums and subsequently the at least two skew drums or vice versa. It has surprisingly been found that separating the bow drums and the skew drums in such a way improves the ability of reducing the curvature of yarns with the bow drums and the ability of adjusting the inclination of yarns with the skew drums while at the same time the risk of warpage of the web is reduced.

[0049] Such successive arrangement can for instance be realized in that the bow drums are arranged along a bow drum plain extending substantially parallel to a skew drum plain in which the at least two skew drums are arranged. The bow drum plain and the skew drum plain can be space from each other by at least 6, 7, 8 or 9 times the diameter of the skew drums and/or of the bow drums. In between the space of the bow drum plain and the skew drum plain, fixed drums of the bow drum arrangement can be arranged along a bow drum arrangement fixed drum plain. Additionally or alternatively fixed drums of the skew drum arrangement can be arranged along a skew drum arrangement fixed drum plain. The bow drum arrangement fixed drum plain and the skew drum arrangement fixed drum plain can extend substantially parallel to each other. Additionally or alternatively the bow drum arrangement fixed drum plain and/or the skew drum arrangement fixed drum plain can extend substantially parallel to the bow drum plain and/or to the skew drum plain. Additionally or alternatively, the bow drum arrangement fixed drum plain can be spaced by at least once or twice the diameter of the fixed drums from the bow drum plain. Additionally or alternatively the skew drum arrangement fixed drum plain can be spaced by at least once or twice the diameter of the fixed drums from the skew drum plain. Additionally or alternatively, the bow drum arrangement fixed drum plain can be spaced by at least once or twice the diameter of the fixed drums from the skew drum arrangement fixed drums plain.

[0050] According to an embodiment, the weft straightener can comprise at least one or two balancing drum/s being arranged in a balancing drum plain. As previously described, these drums can be designed as the fixed drums so that they can also be called fixed drums being respectively arranged in a fixed drum plane. The balancing drum plain can be arranged between the bow drum plain and the skew drum plain. In particular, the balancing drum plain can be spaced by at least two times or three times or four times the diameter of the balancing drums from the bow drum plain and/or the skew drum plain. Additionally or alternatively, the balancing drum plain can extend between the bow drum arrangement fixed drum plain and the skew drum arrangement fixed drum plain. Additionally or alternatively the balancing drum plain can be spaced from the bow drum arrangement fixed drum plain and/or from the skew drum arrangement fixed drum plain by at least once or twice the diameter of the fixed drums.

[0051] In a preferred embodiment, the bow drum plain and the skew drum plain encompasses in between their space from each other the bow drum arrangement fixed drum plain and the skew drum arrangement fixed drum plain, wherein preferably, the bow drum arrangement fixed drum plain and the skew drum arrangement fixed drum plain are spaced from each other in which space the balancing drums are located.

[0052] A drum plain within the meaning of the present invention shall be understood as a plain defined by the longitudinal axis of the respective drums. In the case of bow drums, the bow drum plain can be defined by the rotation axis of the bow drums. According to one embodiment, one fixed drum is mounted in web running direction upwards and/or downwards of each of the at least two bow drums in particular in that the fabric web alternately passes bow drums and fixed drums in particular along a

predetermined guiding path. Additionally or alternatively one fixed drum is mounted in web running direction upwards and/or downwards of each of the at least two skew drums in particular in that the fabric web alternately passes skew drums and fixed drums in particular along a predetermined guiding path. In particular, the mounting and the orientation of the fixed drums with respect to the bow drums and/or to the skew drums can be chosen as previously described with respect to the bow drum arrangement and the skew drum arrangement according to their respective embodiments.

[0053] According to the invention, at least two or three fixed drums are located in web-running direction in between the bow drum arrangement and the skew drum arrangement. In particular the fixed drum can extend in a rectilinear manner and/or can be mounted in a fixed orientation relative to the rotation axis of the bow drums and/or of the skew drums. In particular, the drum can extend along a longitudinal axis extending parallel to the rotation axis of the at least one bow drum and/or to the longitudinal axis of the fixed drums.

[0054] The plurality of fixed drums according to the invention can be designed and/or located as previously described with respect to the balancing drums. The inventors have found that such an arrangement according to the invention can balance the strain distribution caused by the bow drum and/or the skew drum in cross direction of the web. Therefore, these fixed drums can also be called balancing drums. Thereby, it can be ensured that the web facing a downwards arranged drum, for instance the skew drum, is less impaired by the strain distribution in cross direction caused by the previous drum, such as the bow drum. It has been found that increasing the length of the path along the balancing drums and/or the number of the balancing drums increases the uniformity of the strain in the web in cross direction. Therefore, it has been found particularly advantageous to implement at least two balancing drums being spaced from each other by at least three times, five times or seven times the diameter of the bow drum or the skew drum. Thereby a guiding path between these two balancing drums with the length of at least the distance between these drums can be provided, thereby increasing the uniformity of the stress in cross direction in the web facing the downwards drum, such as the skew drum. In order to further increase this effect, it has been found advantageous to additionally or alternatively space at least one balancing drum by at least 3 times or 4 times the diameter of the bow drum or the skew drum from an upwards mounted bow drum and/or skew drum. Additionally or/alternatively it has been found advantageous to space one of the at least two balancing drums by at least 2 times, 4 times or 6 times the diameter of the bow drum or the skew drum from a downwards mounted bow drum and/or skew drum.

[0055] According to an embodiment, each of the two drum arrangements comprise a plurality of drums being arranged in that the fabric-web is deflected in a sinus like manner along or against a first direction through each drum arrangement.

[0056] The deflection along a sinus like manner can be realized as previously described. In particular one of the two drum arrangements can comprise at least two or three, bow drums being alternately arranged with fixed drums in that the fabric-web is deflected in a sinus like manner while the other drum arrangement can comprise at least two or three, skew drums being alternately arranged with fixed drums in that the fabric is deflected in a sinus like manner. The deflection in a sinus like manner along the first direction can be understood in that the first direction is the direction in which the sinus like course of the fabric web extends. In particular, in a classic sinus curve protruding along an x-axis and having its maxima and minima on the y-axis, the first direction extends parallel to the x-axis. Preferably, the first direction is a vertical direction, in particular the gravitational direction. It shall be clear that the deflection in a sinus like manner does not necessarily mean that the fabric web is deflected along a perfect sinus curve. Rather, the sinus like manner shall mean that the fabric web is deflected in loops being aligned along the first direction. Alternatively, it could also be said that the fabric web is deflected in a meandering manner.

[0057] According to this embodiment, the two drum arrangements are arranged next to each other in a second direction extending orthogonal to the first direction. In particular the second direction is a horizontal direction. Next to each other can be understood as the opposite of an extension in one line. In particular, next to each other can be understood in that the path, in particular the predetermined guiding path, along which the fabric web is deflected comprises two sinus like sections extending at least partially on the same height in the first direction, in other words at least partially overlap each other in the first direction. In a preferred embodiment, the sinus like sections overlap each other in the first direction for at least a length corresponding to the diameter of at least one, two thee, four, five or six of the plurality of drums, in particular of the bow drums, skew drums and/or fixed drums of the respective drum arrangements. In other words, at least two, three, four, five or six of the drums, in particular the bow drums and the fixed drums, of one of the drum arrangements are located in the first direction on substantially the same height as at least two, three, four, five or six of the drums, in particular the skew drums and the fixed drums, of the other drum arrangement. In this context, substantially can in particular mean that drums with axis being spaced from each other in the first direction about 10%, 20%, 40%, 60%, 80%, 100%, 150% or 200% of their diameter shall be considered to be on the same height.

[0058] The inventors of the present invention have found that the inventive concept of the present invention, namely the separation of bow error correction from skew error correction by separating the bow drums from the skew drums, increases the required numbers of fixed drums. In conventional weft straighteners, the drums are

arranged in that the fabric alternates along one single sinus like path in one direction, namely in vertical direction. A problem arising with the inventive concept is that such single like path would require an increased height of the weft straightener which makes it more difficult to reach the upper drums for purpose of maintenance, reparation or remedy of standstill. Further, such increased height would require increasing the strength of the support structure so that it can carry the heavy weight of the drums on a limited extension in horizontal direction. This would require stronger materials or higher material thickness of the support structure which would increase costs and decrease sustainability of the straightener. The inventors have found that all these drawbacks can be remedied by this embodiment of the invention. Surprisingly, the inventors have found that the separation into two sinus-like guiding paths does not only not impair the quality of the weft straightening. It even increases the weft straightening by enabling to establish balancing path of balancing by drums/fixed drums in between both drum arrangements as previously described.

[0059] In one embodiment, the drum arrangements can be spaced from each other in the second direction. This can in particular be realized by arranging the drums of the drum arrangement as previously described with respect to the bow drum plane, skew drum plane, bow drum arrangement fixed drum plane and skew drum arrangement fixed drum plane. In particular, the one drum arrangement in can comprise bow drums and fixed drums being spaced from each other in the second direction while the other bow drum arrangement comprises skew drums and fixed drums being spaced from each other in the second direction. Additionally or alternatively, the smallest space between drums of one drum arrangement to drums of another drum arrangement in the second direction can be a space corresponding to at least 0.3, 0.5, 0.7, 0,9, 1.0, 1,1, 1,3 or 1,5 the diameter of one, more or all of its drums.

[0060] In one embodiment, the weft straightener comprises two fixed drums being mounted in web-running direction in between the two drum arrangements and being spaced from each other in the first direction in that the fabric-web is in web-running direction first deflected through one of the drum arrangement along the first direction, subsequently over the two fixed drums against the first direction and finally through the other of the drum arrangements along the first direction. Preferably, the first drum arrangement in web running direction is a bow drum arrangement and the second drum arrangement in web running direction is a skew drum arrangement. Additionally or alternatively, the two fixed drums being mounted in between the two drum arrangements are preferably designed and/or located as previously described with respect to the balancing drums. In particular the fixed drums are located in that between the two drum arrangements that before being conveyed against the first direction, the fabric web is conveyed from the first drum arrangement along the second direction to a first of at least two fixed drums in web running direction. Additionally or alternatively, the fixed drums are located in that between the two drum arrangements that after being conveyed against the first direction, the fabric web is conveyed from a second and/or third of the at least two fixed drums along the second direction to second drum arrangement.

[0061] A second aspect of the invention relates to a method for straightening a fabric web in a fabric web manufacturing line. According to the second aspect, straightening a fabric can in particular mean reducing the curvature of yarns in the fabric web, in particular of weft yarns in a woven fabric web. The method can be performed according to the operation of the weft straightener according to the first aspect of the invention.

[0062] In an embodiment the method according to the invention comprises the step of conveying the fabric web over at least one bow drum and over a plurality of fixed drums in the bow drum arrangement in that the at least one bow drum directly receives the fabric web from one fixed drum and directly delivers the fabric web to one fixed drum. Alternatively, this embodiment could be formulated as conveying the fabric web over at least one of the bow drums and over a plurality of fixed drums in that the web is conveyed in web running direction from an upwards mounted fixed drum directly to the at least one bow drum and from the at least one bow drum directly to a downwards mounted fixed drum. Yet alternatively, this step could be formulated as conveying the fabric web over at least one bow drum and over at a plurality of fixed drums in that the fabric web is conveyed in web running direction from an upwards mounted fixed drum directly to at least one bow and from the at least one bow drum directly to a downwards mounted fixed drum. The at least one bow drum can be rotatably mounted about a rotation axis. The plurality fixed drums can be mounted in a fixed orientation relative to the rotation axis.

[0063] Guiding the web directly from an upwards mounted fixed drum to the at least one bow drum and directly from the at least one bow drum to a downwards mounted fixed drum ensures that the orientation of the fixed drums does not change during the operation of the method. Thereby, the accuracy with which the curvature of the yarns can be reduced can be increased. Further, energy can be saved which would be necessary for keeping a pivotably mounted fixed drum in a fixed orientation.

[0064] In a preferred embodiment, the plurality of fixed drums extend along longitudinal axis extending parallel to the rotation axis of the bow drum. The parallel extension of the rotation axis with the bow drum ensures that the strain distribution in cross direction caused by the curved bow drum is not superposed by an additional inconstant stress distribution which would for instance be caused by a skew drum.

[0065] Conveying the web over the bow drum can comprise conveying the web of at least two, in particular at least three, bow drums in an alternating manner with the at least two, in particular at least three, fixed drums. Con-

veying the web in an alternating manner can in particular be realized in that the web is conveyed in web running direction from each fixed drum directly to a respective bow drum and/or in that the web is conveyed in web running direction from each bow drum directly to a respective fixed drum.

[0066] Directly conveying the web from one drum to another drum can be understood in that the web extends straight between these two drums, in particular the guiding path of the web between these two drums is free of additional drums deflecting the web in between.

[0067] In a preferred embodiment, the web is guided from the first fixed drum directly to a first bow drum, from the first bow drum directly to a second fixed drum and from the second fixed drum directly to a second bow drum. Preferably, the web can additionally be guided from the second bow drum directly to a third fixed drum and from the third fixed drum directly to a third bow drum. Preferably, the web is deflected by at least one, two or three of the bow drums and/or of the fixed drums by at least 90°, 120°, 150° or 180°. Preferably, the web is guided in a meandering or sinus like manner between the at least one bow drum and the at least two fixed drums. The web can extend in a substantially horizontal orientation between a bow drum and a fixed drum.

[0068] Conveying the web of at least two bow drums in an alternating manner with at least two fixed drums can in particular be realized in that the web is alternately reflected by the at least two bow drums and the at least two fixed drums.

[0069] According to an embodiment, straightening a fabric can in particular mean adjusting the inclination of yarns in a fabric web, in particular of weft yarns in a woven fabric.

[0070] The method according to this embodiment comprises the step of conveying the fabric web over at least one of the skew drums and over a plurality of fixed drums in the skew drum arrangement, such that the at least one skew drum directly receives the fabric web from one fixed drum and directly delivers the fabric web to one fixed drum. Alternatively, this embodiment could be formulated as conveying the fabric web over at least one skew drum and over a plurality of fixed drums in that the web is conveyed in web running direction from an upwards mounted fixed drum directly to the skew drum and from the skew drum directly to a downwards mounted fixed drum. Yet alternatively, this embodiment could be formulated as conveying the fabric web over at least one skew drum and over at a plurality of fixed drums in that the web is conveyed in web running direction from an upwards mounted fixed drum directly to the skew drum and from the skew drum directly to a downwards mounted fixed drum. The skew drum can be pivotably mounted about a pivot axis.

[0071] The at least two fixed drums can extend in a rectilinear manner. The extension of the at least two fixed drums in a rectilinear manner could alternatively be described in that the at least two fixed drums extend along a straight longitudinal axis, in particular comprise a cylindrical guiding surface extending along a straight longitudinal axis. In particular, the at least two fixed drums shall be not curved. Guiding the web directly from such fixed drum to the at least one skew drum and from the at least one skew drum directly to such fixed drum ensures that the strain distribution of the web is not superposed by an additional varying strain distribution in cross direction as it would be the case if the web would be directly delivered from a bow drum to the skew drum or if the web would be directly delivered from the skew drum to a bow drum.

[0072] According to an embodiment, conveying the web over the at least one skew drum can comprise conveying the web over at least two, in particular at least three, skew drums in an alternating manner with the plurality of fixed drums, in particular in that the web is conveyed in web running direction from each fixed drum directly to a respective skew drum and/or in that the web is conveyed in web running direction from each skew drum directly to a respective fixed drum. Additionally or alternatively, conveying the web over at least two skew drums in an alternating manner with at least two fixed drums can be realized as described for such alternation of bow drums and fixed drums.

[0073] The method according to this embodiment can comprise pivoting the at least one skew drum before and/or during the step of conveying the web over the at least one skew drum and the plurality of fixed drums. Thereby, the inclination of the yarns can be adjusted from web to web or within the web from length section to length section. The latter one can be of particular advantage if it is found that the inclination of the yarns in cross direction is not constant in web running direction.

[0074] The method can comprise the step of rotating the at least one bow drum about its rotation axis before and/or during the step of conveying the web over the at least one bow drum and the plurality of fixed drums.

[0075] According to an embodiment, straightening a fabric can in particular mean reducing the curvature and adjusting the inclination of yarns in the fabric web, in particular of weft yarns in a woven fabric web. The reduction of the curvature can be conducted according to the embodiment comprising the bow drum arrangement as described above. The adjustment of the inclination can be conducted according to the embodiment comprising the skew drum arrangement as described above. The method according to the invention comprises the step of conveying the fabric web over at least two bow drums and over at least two skew drums. This step can be conducted according to the operation of the weft straightener being previously described.

[0076] According to the invention, the fabric web is conveyed in web running direction first over the at least two bow drums and subsequently over the at least two skew drums or vice versa. In a preferred embodiment, the web is conveyed first over at least three bow drums and subsequently over at least three skew drums or vice versa.

[0077] According to the invention, the fabric web is in web-running direction deflected by the at least two fixed drums before being delivered from the at least two bow drums to the at least two skew drums or vice versa.

[0078] In an embodiment, the method comprises the step of conveying the fabric-web in a sinus like manner along or against a first direction through two drum arrangements. According to this embodiment, the fabric web is conveyed through the two drum arrangement along separate sinus like paths being located next to each other in a second direction extending orthogonal to the first direction.

[0079] In particular, before guiding the fabric web from the last bow drum in web running direction to the first skew drum in web running direction or vice versa, the fabric web can be conveyed over at least two or three balancing drums. In particular, the web can in a first step be conveyed in an alternating, in particular meandering, manner between at least two bow drums and at least two fixed drums, in particular between at least three bow drums and at least three fixed drums. In a second step, the web can be guided over at least two or at least three balancing drums to a skew drum arrangement. Within the skew drum arrangement, the fabric web can be conveyed in an alternating manner, in particular in a meandering manner, over at least two skew drums and at least two fixed drums, in particular over at least three skew drums and over at least three fixed drums. In a fourth step, the fabric web can be guided along a measuring apparatus for measuring the curvature and the inclination of the yarns extending in cross direction of the web. Conveying the web in a meandering manner shall in particular be understood as a synonym for the previously described sinus like manner.

[0080] An embodiment of the invention relates to a method for straightening a fabric web comprising warp yarns extending in warp direction and weft yarns extending crosswise the warp direction in a fabric web manufacturing line. Straightening a fabric web can particularly mean preventing warpage of a fabric web, in particular of a woven fabric web. This embodiment comprises adjusting the inclination of the weft yarns of a the fabric web in a weft angle of at least 1 degree and of maximally 30 degree, in particular of at least 2 degree and maximally 20 degree, relative to a theoretical weft yarn direction extending orthogonal to the warp yarns. The adjustment of the orientation of the weft yarns can in particular be realized by the operation of the weft straightener. Preferably, adjusting the inclination of the weft yarns is conducted by the operation of the skew drum arrangement according to the previously described embodiments.

[0081] The inventors of the present invention have surprisingly found that warpage of a fabric caused by finishing processes, such as washing, can be reduced or even avoided by adjusting the inclination of the weft yarns within the claimed range. It has been found that the inclination avoiding warpage of the woven fabric depends strongly on the weave pattern. For instance, it has been found that a weft angle of 1 degree to 3 degree, in particular of 2 degree to 3 degree, is advantageous for avoiding warpage in a 2/1 twill weave. For a 3/1 twill weave, it has been found advantageous to adjust the inclination to a weft angle of between 3 degree and 8 degree, in particular between 4 degree and 6 degree. For a 4/1 twill weave, it has been found advantageous to adjust the inclination to a weft angle between 10 degree and 30 degree, in particular between 13 degree and 20 degree.

[0082] Thus, this embodiment preferably comprises the step of choosing the weft angle in dependence of the weave pattern of the fabric. The method can be used for preventing warpage of a twill weave fabric. Twill weave fabrics can be distinguished from each other by the float length of the weave. The float length is a number of the yarns bypassed by the long floats of a weave. For instance, in a 2/1 twill weave, the float length is two. In a 3/1 twill weave, the float length is three. In a 4/1 twill weave, the float length is four and so forth.

[0083] The method can comprise the step of identifying the float length of a fabric, in particular of a twill weave fabric. This can be done by optical analysis of the fabric or by requesting the float length of the fabric from a data base in which it is saved or by asking a person having produced the fabric.

[0084] Further, the method can comprise the step of choosing the weft angle in dependence of the float length of the twill weave. This step can comprise choosing a weft angle of 1 to 3 degree, in particular of 2 to 3 degree, for a float length of two, in particular for a 2/1 twill weave, choosing a weft angle of 3 to 8 degree, in particular of 4 to 6 degree, for a float length of three, in particular for a 3/1 twill weave, and/or choosing a weft angle of 10 degree to 30 degree, in particular of 13 degree to 20 degree, for a float length of four, in particular for a 4/1 twill weave.

[0085] After choosing the twill weave, the method can comprise the step of adjusting the inclination of the weft yarns of the fabric within the chosen weft angle range by means of a skew drum arrangement and/or a weft straightener. This step can particularly comprise measuring the inclination of the weft yarns before entering the straightener, identifying the required pivot angle of the at least one skew drum for adjusting the inclination of the weft yarns into the chosen inclination range and conveying the fabric through the skew drum arrangement. In cases in which the inclination of the fabrics is already known, for instance by experience, the step of measuring the inclination of the weft yarns in the fabrics can be omitted.

[0086] A woven fabric, comprising warp yarns extending in warp direction and weft yarns extending crosswise the warp direction can be processed according to the method of the invention.

[0087] The weft yarns of the fabric extend in a weft angle of at least 1 degree and of maximally 30 degree, in particular of at least 2 degree and of maximally 20 degree, relative to the theoretical weft yarn direction extending orthogonal to the warp yarns. The weft yarn angle

can be measured by measuring the length of a line extending from one end of the weft yarn on a first end of the fabric to the other end of the weft yarn at the opposite end of the fabric in cross direction. By geometrical calculations, such as the theory of Pythagoras, the weft angle can be calculated from this measured length and the width of the fabric in cross direction.

[0088] Preferably, the weft yarn extends substantially straight within the fabric. Substantially straight can be understand in that the distance of the weft yarn from the before mentioned line drawn for calculating the weft angle, shall be smaller than 2 centimetre, 1.5 centimetre, 1 centimetre, 0.5 centimetre, 0.3 centimetre or 0.1 centimetre along the entire extension of the weft yarn. Additionally or alternatively, the weft yarns shall have no buckle at about 1/3 of the fabric extension in weft direction. Such buckling could be identified in that the distance between the weft yarn and the before mentioned drawn theoretical line has a maximum about 1/3 of the fabric extension in weft direction.

[0089] The woven fabric can be a twill weave. Preferably, the fabric is a twill weave with a flow length of two, in particular a 2/1 twill weave, having a weft angle between 1 degree and 3 degree, in particular between 2 degree and 3 degree. Alternatively, the twill weave fabric can be a fabric having a float length of 3, in particular a 3/1 twill weave, having a weft angle between 3 degree and 8 degree, in particular between 4 degree and 6 degree. Alternatively, the twill weave fabric can have a float length of 4, in particular can be 4/1 twill weave, having a weft angle between 10 degree and 30 degree, in particular between 13 degree and 20 degree.

[0090] The web can be conveyed in a strained condition. In particular, the web can be strained in web running direction.

[0091] Further aspects, properties and features of the invention will become apparent from the following description of exemplary embodiments, taken in conjunction with the accompanying drawings, in which:

Figure 1 shows perspective cross section view on a weft straightener according to the figures 3 and 4 along the cutting line C-C shown in figure 4;

Figure 2 shows a side cross sectional view on the weft straightener along the cutting line C-C illustrated in figure 4;

Figure 3 shows a perspective view on a weft straightener;

Figure 4 shows a backside view on the weft straightener shown in figure 3;

Figure 5a shows a schematic illustration of a 2/1 twill weave fabric with weft angle α_1;

Figure 5b shows a schematic illustration of a 3/1 z twill weave with a weft angle α_2;

Figure 5c shows a schematic illustration of a 3/1 s twill weave with a weft angle α_3;

Figure 5d shows a schematic illustration of a 4/1 twill weave with a weft angle α_4;

Figure 6 shows a schematic illustration of a weft straightener known in the art; and

Figure 7 shows a schematic illustration of a buckled extension of weft yarns in a fabric being processed with a weft straightener known in the art.

[0092] The figures 3 and 4 show a weft straightener 1. The weft straightener 1 comprises a support structure comprising two support stands 3 being spaced from each other in cross direction C so as to provide a receiving space for drums of the weft straightener 1. The support stands are connected with each other by three connecting bars 5 extending in cross direction C. The support stands 3 and connecting bars 5 are illustrated partially transparent so as to show the course of the web 7 being conveyed in a meandering manner through the weft straightener 1. As previously described, the term web 7 is used as synonym for fabric web 7.

[0093] The direction in which the web 7 is conveyed through the weft straightener 1 is designated with reference sign W. As can be seen in figure 3, the web running direction W has not a fixed orientation. The web running direction W changes with the orientation of the web 7 in the weft straightener 1. The web running direction W is the longitudinal direction of the web 7. In the case of a woven fabric, the web running direction W relates to the direction of the warp yarns. The cross direction C is the direction in which the web 7 extends orthogonal to the web running direction W. In the case of a woven fabric, the cross direction C is the theoretical direction in which the weft yarns extend, in particular a direction running orthogonal to the warp direction. Figure 4 illustrates a backside view on the weft straightener 1 shown in figure 3 with a cut line A-A illustrating the position of the cross section view shown in the figures 1 and 2.

[0094] The weft straightener 1 will now be described in more detail with reference to the figures 1 and 2. The weft straightener 1 comprises a bow drum arrangement 9 and a skew drum arrangement 11. The bow drum arrangement 9 is shown on the left side of figure 1 and 2. The skew drum arrangement 11 is shown on the right side of figure 1 and 2. Together, the bow drum arrangement 9 and the skew drum arrangement 11 form a weft straightener 1.

[0095] The bow drum arrangement 9 comprises three bow drums 13 and three fixed drums 15, 17. As can be seen in figure 2, the bow drums 13 are rotatably mounted about a rotation axis 19. Upon rotating the bow drums 13 about the rotation axis 19, the vertex 21 of the bow drum can be rotated towards the fixed drum 15, 17 or away from the fixed drums 15, 17. Upon rotating the vertex 21 towards the fixed drums 15, 17, a convex side of the bow drums 19 faces the fixed drums 15, 17. Upon rotating the vertex 21 of the bow drums 19 away from the fixed drums 15, 17, a concave side of the bow drums faces the fixed drums. Thereby, the strain distribution in

the web 7 caused by the bow drums 13 can be settled. For instance, if the convex side of the bow drums 19 faces the fixed drums 15, 17, the middle of the bow drums in cross direction C is closer to the fixed drums 15, 17 than the end sections of the bow drums 19 in cross direction. Thus, the end sections of the web 7 have to be conveyed over a longer distance between the bow drums 13 and the fixed drums 15, 17 so that they are strained to a greater extent compared to the middle of the web 7. To the contrary, when the concave side of the bow drums 13 faces the fixed drums 15, 17, the end sections of the web 7 in cross direction C are closer to the fixed drums 13, 17, so that the middle section is strained to a greater extend. Thus, upon rotating the bow drums 13 about the rotation axis 19, the strain distribution within the web in cross direction C can be adjusted. Thereby, the curvature of yarns in a web can be reduced by differently straining the middle section and the end sections of the web 7.

[0096] As can be seen from figure 4, bow drums 13 preferably extend in a circular section manner having the vertex 21 in the middle of the bow drums 13 in cross direction C.

[0097] The course of the web illustrates the guiding path. In the illustrated bow drum arrangement 9, each of the three fixed drums 15, 17 are mounted upwards one of each bow drum 13 in that the guiding path extends in web running direction W from the upwards mounted fixed drum 15 directly to one of the three bow drums 13. In addition, the second and third fixed drums 15, 17 are mounted downwards the first and the second bow drum 13 in that the guiding path extends in web running direction W from the first bow drum 13 directly to the second fixed drum 17 being mounted downwards with respect to the first bow drum and from the second bow drum directly to the third fixed drum 17 being mounted downwards with respect to the second bow drum 13.

[0098] When a drum is in the following designated as first, second or third drum, the numbering shall relate to the succession in which the drums are passed by the web 7 in web running direction W. For instance, the first bow drum 13 is passed by the web before the second bow drum 13 while the second bow drum 13 is passed by the web before the third bow drum 13.

[0099] Further, the terms upwards and downwards shall relate to the web running direction W in that an upwards mounted drum is passed by the web W before the downwards mounted drum in web running direction.

[0100] In the embodiment illustrated in the figures 1 to 4, the first fixed drum 15 is mounted upwards the first bow drum 13. The second fixed drum 15, 17 is mounted downwards the first bow drum 13 and upwards the second bow drum 13. The third fixed drum 15, 17 is mounted downwards the second bow drum 13 and upwards the third bow drum 13.

[0101] The three fixed drums 15, 17 of the bow drum arrangement 9 are mounted in a fixed orientation relative to the rotation axis 19. In the illustrated embodiment, this is realized in that the fixed drums 15, 17 are fixedly mounted on the support structure in that they cannot be pivoted. In particular, the fixed drums 15, 17 extend along longitudinal axis 23 having an orientation which cannot be changed with respect to the rotation axis 19.

[0102] The rotation axis 19 extends substantially parallel to the cross direction C. In the illustration embodiment, the rotation axis 19 extends perfectly parallel to the cross direction C. However, as described above, a certain angle between the rotation axis 19 to the cross direction C can be allowed. As can be seen in figure 4, the bow drums 13 have a curved cylindrical shape extending along a curved bow drum axis 25.

[0103] In the embodiment shown in figure 2, the longitudinal axis 23 of the fixed drums 15, 17 extends parallel to the rotation axis 19. However, as described above, a certain angle between the rotation axis 19 and the longitudinal axis 23 can be allowed. Nevertheless, it has been found particularly advantages to choose the fixed orientation of the fixed drums 15, 17 in that their longitudinal axis extends perfectly parallel to the rotation axis 19 of the bow drums 13. Thereby, the disadvantages superposition of strain distributions caused by the bow drum and a fixed drum or a skew drum extending not parallel to the rotation axis, as discussed below with respect to figure 6 and 7, can be avoided.

[0104] The three bow drums 13 are mounted in an alternating manner with the three fixed drums 15, 17 in that each of the three fixed drums 15, 17 is mounted upwards a respective bow drum 13 along the guiding path in that the guiding path extends in web running direction W from each upwards mounted fixed drum 15 directly to a respective bow drum 13.

[0105] The bow drum arrangement shown in the figures 1 to 4 can be used for reducing the curvature of yarns. Thereby, the web can be conveyed over the first bow drum 13 in that the web 7 is conveyed in web running direction W from the upwards mounted first fixed drum 15 directly to the first bow drum 13 and from the first bow drum 13 directly to the downwards mounted second fixed drum 17. Additionally, the web 7 can be guided from the second fixed drum 15 being upwards mounted with respect to the second bow drum 13 directly to the second bow drum 13 and from the second bow drum 13 directly to the third fixed drum 17 being downwards mounted with respect to the second bow drum.

[0106] In particular, with the bow drum arrangement 9 shown in the figures 1 to 4, the web 7 can be conveyed over the three bow drums 13 and the three fixed drums 15, 17 in an alternating manner in that the web 7 is conveyed in web running direction W from each fixed drum 15, directly to a respective bow drum 13. Additionally, the web is guided from the first and second bow drum 13 directly to the second and third fixed drum 17. The skew drum arrangement 11 comprises three skew drums 27 being pivotably mounted about a pivot axis 29. The skew drums 27 have a cylindrical shape extending along a rectilinear skew drum axis 31. The embodiments shown in the figures 1 to 4 show a preferred embodiment in which

the three skew drums 27 have a common pivot axis 29. As can be seen in the figures 1 to 3, the pivotable mounting of the skew drums 27 is realized by a pivot frame 33. The pivot frame 33 comprises two pivot bars 35 extending in cross direction C and being spaced from each in vertical direction V so as to encompass in between the three skew drums 31. The pivot frame 33 further comprises two connecting walls 37 extending in vertical direction V and connecting the end sections of the pivot bars 35 with each other. The skew drums 27 are connected with their end sections in cross direction C with the connecting walls 37. The connecting walls 37 and the pivot walls 35 form a rectangular pivot frame 33. As can be seen in the figures 1 and 2, the pivot frame 33 is pivotably mounted with pivot bearings 39. The pivot bearings can be implemented in bearing bars 41 extending in cross direction C from one support stand 3 to the other support stand 3. As can be seen in figure 1 and 2, the pivot bearings 39 can be located in the middle of the bearing bars 41 in cross direction C. The pivot axis 29 extends orthogonal to the cross direction C. In particular, the pivot axis 29 extends in vertical direction V.

[0107] The skew drum arrangement 11 further comprises three fixed drums 43, 45 each of which being mounted downwards a respective skew drum 27. The first fixed drum 43, 45 is mounted downwards with respect to the first skew drum 27 and upwards with respect to the second skew drum. The second fixed drum 43, 45 is mounted downwards with respect to the second skew drum 27 and upwards with respect to the third skew drum 27. The third fixed drum 45 is mounted downwards the third skew drum 27. Thereby, the first and second skew drum 43, 45, are mounted upwards and downwards the second bow drum 27 in that the guiding path extends in web running direction W from the first fixed drum 43, 45, directly to the second skew drum and from the second skew drum directly to the second fixed drum 43, 45. Further, the second fixed drum 43, 45 and the third fixed drum 45 are mounted upwards and downwards the third skew drum 27 in that the guiding path extends in web running direction W from the second fixed drum directly to the third skew drum 27 and from the third skew drum 27 directly to the third fixed drum 45.

[0108] As can be seen from figure 2, the three fixed drums 43, 45 of the skew drum arrangement 11 extend in a rectilinear manner. In other words, the three fixed drums 43, 45 extend along a straight longitudinal axis. In yet other words, the fixed drums 43, 45 of the skew drum arrangement 11 are not curved, in particular are not bow drums. Thereby, the undesired superposition of strain distributions caused by the direct sequence of a bow drum and a skew drum as practiced with known weft straighteners can be avoided.

[0109] As indicated with the crosses in the inner circles, the fixed drums 15, 17 of the bow drum arrangement 9, the fixed drums 43, 45 of the skew drum arrangement 11, and/or the skew drums can be rotatably mounted about their longitudinal axis 23 and/or skew drum axis 31.

[0110] The method for adjusting the inclination of yarns in a web 7 according to the invention can be conducted with a skew drum arrangement 11 as shown in the figures 1 to 4. Therefore, the web 7 can be conveyed over the second skew drum 27 and the first and second fixed drums 43, 45 in that the web 7 is conveyed in web running direction from the first fixed drum 43 being mounted upwards with respect to the second skew drum 27 directly to the second skew drum 27 and from the second skew drum 27 directly to the second fixed drum 43, being mounted downwards with respect to the second skew drum 27. Additionally, the web 7 can be guided over the third skew drum 27 and the second and third fixed drums 43, 45 in that the web 7 is conveyed in web running direction W from the second fixed drum 43, 45 being mounted upwards with respect to the third skew drum 27 directly to the third skew drum 27 and from the third skew drum 27 directly to the third fixed drum 45 being mounted downwards the third skew drum 27.

[0111] Additionally, the web can be conveyed over the three skew drums 27 in an alternating manner with the three fixed drums 43, 45 in that the web 7 is conveyed in web running direction W from each of the skew drums 27 directly to a respective fixed drum 43, 45. Additionally, the web can be conveyed over the second and third skew drum 27 in an alternating manner with the first and second fixed drum 45 in that the web 7 is conveyed in web running direction W from the first fixed drum 43, 45 directly to the second skew drum 27 and from the second fixed drum 43, 45 directly to the third skew drum 27.

[0112] As described above, the weft straightener 1 shown in the figures 1 to 4 can be used for reducing the curvature of yarns in a web 7 and for adjusting the inclination of the yarns in the web 7. The bow drum arrangement 9 and the skew drum arrangement 11 are arranged successively in that the predetermined guiding path for the web 7 passes in web running direction W first the three bow drums 13 and subsequently the three skew drums 27. Thereby, the reduction of the curvature of the yarns with the bow drum arrangement 9 and the adjustment of the inclination of the yarns with the skew drum arrangement 11 can be timely separated from each other so that the undesired superposition of strain distribution caused by directly conveying the web from a skew drum to a bow drum or vice versa can be avoided.

[0113] As shown in figure 2, the weft straightener 1 comprises balancing drums 47 being arranged in web running direction W between the bow drums 13 and the skew drums 27. As previously described, the balancing drums 47 can be designed like the fixed drums and can therefore also be named fixed drums. Thereby, the strain distribution caused by conveying the web 7 over the three bow drums 13 can be balanced within the course of the web 7 along the balancing drums 47 so that the undesired effect of superposing the strain distribution of the bow drums and the skew drums can be further reduced. The balancing drums 47 can extend in a rectilinear manner. In particular, the balancing drums 47 can extend along

balancing drum axis 49 extending parallel to the longitudinal axis 23 of the fixed drums 15, 17, 43, 45 and/or to the rotation axis 19 of the bow drums 13.

[0114] In particular, such weft straightener is capable for reducing the curvature of yarns and for adjusting the inclination of yarns in a web. In particular, the web can be conveyed first over the three bow drums 13 and subsequently over the skew three drums 27.

[0115] As can best be seen in figure 2, the three fixed drums 15, 27 of the bow drum arrangement 9 are mounted in a common bow drum arrangement fixed drum plane 51. This means that the longitudinal axes 23 of the fixed drums 15, 17 are arranged in a common flat plane 51. In particular, the longitudinal axis 23 of the fixed drums 15, 17 extend parallel to each other. The bow drum arrangement fixed drum plane 51 extends in vertical direction. Within the fixed drum plane 51, the fixed drums 15, 17 are spaced from each other in vertical direction. The bow drums 13 are spaced from the fixed drum plane 51 in the orthogonal direction to the bow drum arrangement fixed drum plane 51. In particular, the bow drums 13 are also arranged in a common bow drum plane 53. The rotation axis 19 of the bow drums 13 are spaced from each other in vertical direction in particular within the bow drum plane 53. The bow drum plane 53 extends in vertical direction V. The bow drum plane 53 and the bow drum arrangement fixed drum plane 51 extend parallel to each other. Further, the bow drum plane 53 and the bow drum arrangement fixed drum plane 51 are spaced from each other in particular in orthogonal direction to the extension of the bow drum plane 53.

[0116] The fixed drums 43, 45 of the skew drum arrangement 11 are mounted in a common skew drum arrangement fixed drum plane 55. The skew drum arrangement fixed drum plane extends in vertical direction V. Within the skew drum arrangement fixed drum plane 55, the fixed drums 43, 45 are spaced from each other in vertical direction V. In addition, the skew drums 27 are spaced in orthogonal direction from the skew drum arrangement fixed drum plane 55. The skew drums 27 are located in a common skew drum plane 57. Within the skew drum plane 57, the skew drums 27 are spaced from each other in vertical direction V. The skew drum plane 57 extends parallel to the skew drum arrangement fixed drum plane 55. The skew drum plane 57 is spaced from the skew drum arrangement fixed drum plane 55 in orthogonal direction to the extension of the skew drum plane 57.

[0117] In the preferred embodiment shown in figure 2, the bow drum plane 53 and the skew drum plane 29 are spaced from each other in the direction extending orthogonal to the bow drum plane 53. Preferably, the space between the bow drum plane 53 and the skew drum plane 57 is large enough so as to locate the bow drum arrangement fixed drum plane 51 and/or the skew drum arrangement fixed drum plane 55 in between. Preferably, the bow drum arrangement fixed drum plane 51 and the skew drum arrangement fixed drum plane 55 extend in between the bow drum plane 53 and the skew drum plane 57. Preferably, the bow drum arrangement fixed drum plane 51 and the skew drum arrangement fixed drum plane 55 are spaced from each other in orthogonal direction of the bow drum arrangement fixed drum plane. Preferably, at least two balancing drums 47 are located between the bow drum arrangement fixed drum plane 51 and the skew drum arrangement fixed drum plane 55.

[0118] The weft straightener 1 comprises a feeding drum 59 which is mounted on the top of the support structure so as to feed the weft straightener 1 from the top with a web 7. Therefore, as shown in figure 3, the feeding drum 59 can be mounted, in particular rotatably mounted, on the top of the support stands 3 of the weft straightener.

[0119] Additionally, the weft straightener 1 can comprise an exit drum 61 for deflecting the web 7 at the end of the weft straightener 1 in web running direction W out of the weft straightener 1. The exit drum 61 can be located in vertical direction V below all drums of the weft straightener 1. The exit drum 61 can be rotatably mounted between the two support stands 3.

[0120] The weft straightener 1 can comprise a measuring device 63 for measuring the curvature of the yarns extending in cross direction C and the inclination of the yarns extending in cross direction C after leaving the bow drum arrangement 9 and/or the skew drum arrangement 11. The measuring device 63 can comprise at least two measuring units 65 being spaced from each other in cross direction C so as to measure the curvature and the inclination of the yarns in different sections in cross direction C of the web 7. In figures 1 to 4 such measuring units are designated with reference sign 65. The weft straightener 1 can comprise a measuring unit feeding drum 67 being mounted upstream the measuring device 63. The measuring unit feeding drum 67 can be used for deflecting the web 7 into a vertical orientation so as to be guided vertically through the measuring device 63. The exit drum 61 can be located downwards the measuring device 63 so as to deflect the web 7 into a horizontal direction so as to leave the weft straightener 1 in a horizontal orientation.

[0121] The figures 5a to 5d schematically illustrate twill fabrics with warp yarns 69 and weft yarns 71. The warp yarns extend in warp direction W which matches with the web running direction W in the figures 1 to 4. The theoretical weft direction C is indicated with reference sign C which matches with the cross direction C in the figures 1 to 4. The weft yarns 71 in the figures 5a to 5d extend in a weft angle α relative to the theoretical weft direction C. The weft angle α of the fabrics being illustrated in the figures 5a to 5d is between 1 degree and 30 degree. As previously described, it has surprisingly been found that such weft angle can decrease the warpage of a woven fabric compared to woven fabrics with weft yarns extending in the theoretical weft direction C.

[0122] As previously discussed, it has been found that the warpage can be further decreased by choosing the weft angle in dependence of the float length of a twill

fabric. In particular, it has been found advantageous to increase the weft angle α with an increasing float length.

[0123] This is illustrated by the figures 5a to 5d. Therein, figure 5a shows a 2/1 twill fabric, with a float length of two and a weft angle α_1. Compared thereto, the figures 5b and 5c show 3/1 twill fabrics with a float length of three and respectively with weft angle α_2 and α_3 being larger than weft angle α_1 of the 2/1 twill fabric. Figure 5d shows a 4/1 twill fabric with a float length of four and a respective weft angle α_4 being larger the weft angles α_2 and α_3.

[0124] In addition, the inventors have found that aside the float length, the twill direction influences the opportune weft angle α for reducing warpage. In particular, it has been found that in an S-twill, a larger weft angle α is advantageous compared to a Z-twill fabric having the same float length. This has been illustrated with the figures 5b and 5c both showing a 3/1 twill fabrics, wherein figure 5c shows an S-twill fabric having a larger weft angle α_3 compared to figure 5b showing a Z-twill fabric with a smaller weft angle α_2.

[0125] Figure 6 schematically illustrates the guiding path of a web 7 between a skew drum 27 and a bow drum 13 according to known weft straighteners. The pivot axis 29 of the skew drum 27 is designated with reference sign 29. The rotation axis 19 of the bow drum 13 is designated with reference sign 19. The skew drum axis is designated with reference sign 31. The bow drum axis is designated with reference sign 25. The vertex of the bow drum is designated with reference sign 21. The middle section of the web is designated with reference sign 73. The end section of the web 7 is designated with reference sign 75. The right end section of the weft is designated with reference sign 77. The length of the web 7 between the skew drum 27 and the bow drum 21 in the middle section and the end sections of the web is designated with the reference signs 73', 75', 77'.

[0126] As can be seen, guiding the web 7 directly from a skew drum 27 to a bow drum 13 or vice versa leads to different lengths 77', 75' of the end sections 77, 75 of the web 7. In addition, the length difference of the middle section 73 compared to the end sections 75, 77 which is caused by the bow drum 13 is additionally increased for one end section, in this case for the right end section 77, while it is at the same reduced or even nullified for the other end section, in this case for the left end section 75, by the skew drum 27.

[0127] The inventors of the present invention have found that in particular these effects to the length differences between middle section 73 and end sections 75, 77 of the web 7 lead to a superposition of the strain distribution caused by the skew drum 27 and by the bow drum 13. The inventors of the present invention have found that this superposition causes the undesired warpage of the fabric upon washing. Further, it has been found that this superposition also decreases the accuracy with which the curvature of the weft yarns can be reduced and with which the inclination of the weft yarns can be adjusted. It has been found that all these problems can be solved with the inventive concepts of the present invention.

[0128] Figure 7 schematically illustrates the course of weft yarns 71 in a fabric 7 being processed with known weft straighteners. In such fabrics 7, the weft yarns 71 extend buckled, in other words have a buckle 79, at about 1/3 of the extension of the web in cross direction C. Such buckling can impair the visual appearance of the web 7, can weaken the strength of the fabric 7 and can lead to warpage of the fabric 7 upon finishing processes, such as washing. The inventors of the present invention have surprisingly found that such buckled cores of the weft yarns 71 can be reduced or even completely avoided by the use of the inventive solutions.

Reference signs:

[0129]

1	weft straightener
3	support stands
5	connecting bars
7	web, fabric web, woven fabric, woven fabric web
9	bow drum arrangement
11	skew drum arrangement
13	bow drum
15	upwards mounted fixed drum of the bow drum arrangement
17	downwards mounted fixed drum of the bow drum arrangement
19	rotation axis of the bow drums
21	vertex of the bow drums
23	longitudinal axis of the fixed drums
25	curved bow drum axis
27	skew drum
29	pivot axis
31	skew drum axis
33	pivot frame
35	pivot bars
37	connecting walls
39	pivot bearings
41	bearing bars
43	upwards mounted fixed drum of the skew straightener
45	downwards mounted fixed drum of the skew straightener
47	balancing drums / fixed drums
49	balancing drum axis / fixed drum axis
51	bow drum arrangement fixed drum plane
53	bow drum plane
55	skew drum arrangement fixed drum plane
57	skew drum plane
59	feeding drum
61	exit drum
63	measuring device
65	measuring units
67	measuring unit feeding drum
69	warp yarns

71 weft yarns
73 middle section of the web
73' length of the middle section of the web
75 left end section
75' length of the left end section
77 right end section
77' length of the right end section
79 buckle of weft yarns
α weft angle of weft yarns

V Vertical direction
C Cross directions/theoretical weft direction
W Web running direction/warp direction
C-C Cut-line

Claims

1. A weft straightener (1) for a fabric web manufacturing line, comprising:

- a bow drum arrangement (9) comprising at least two bow drums (13);
- a skew drum arrangement (11) comprising at least two skew drums (27),
- at least two fixed drums (47), **characterized in that** the bow drum arrangement (9) and the skew drum arrangement (11) are in web running direction (W) successively arranged such that a fabric web is first deflected by the at least two bow drums (13) and subsequently by the least two skew drums (27) or vice versa; and **in that** the least two fixed drums (47) are located in web-running direction in between the at least one bow drum arrangement (9) and the at least one skew drum arrangement (11) such that the fabric web is deflected by the at least two fixed drums (47) before being delivered from the at least one bow drum arrangement (9) to the at least one skew drum arrangement (11) or vice versa.

2. The weft straightener according to claim 1, **characterized in that** the bow drum arrangement (9) comprises:

- a plurality of fixed drums (15, 17), wherein

at least one of the at least two bow drums (13) is located in web running direction (W) in between two of the plurality of fixed drums (15, 17) such that it receives the fabric web (7) from one fixed drum and delivers the fabric web to one fixed drum.

3. The weft straightener according to claim 2, **characterized in that** each of the at least two bow drums (13) of the bow drum arrangement (9), particularly each of at least three bow drums, is located in web running direction (W) upwards one of the plurality of fixed drums (15, 17) of the bow drum arrangement (9) such that the respective bow drum delivers the fabric web (7) to a fixed drum and/or is located in web running direction downwards one of the plurality of fixed drums of the bow drum arrangement (9) such that the respective bow drum receives the fabric web from a fixed drum, and/or wherein the at least two bow drums (13) and the plurality of fixed drums (15, 17) of the bow drum arrangement (9) are arranged **in that** the fabric web is deflected in a sinus like manner.

4. The weft straightener according to one of the preceding claims,
characterized in that the skew drum arrangement (11) comprises:

- a plurality of fixed drums (43, 45), wherein at least one of the at least two skew drums (27) is located in web running direction (W) in between two of the plurality of fixed drums (43, 45) such that it receives the fabric web (7) from one fixed drum and delivers the fabric web to one fixed drum.

5. The weft straightener according to claim 4, **characterized in that** each of the at least two skew drums (27), particularly each of at least three skew drums, is located in web running direction (W) upwards one of the plurality of fixed drums (43, 45) of the skew drum arrangement (11) such that the respective skew drum delivers the fabric web (7) to a fixed drum and/or is located in web running direction downwards one of the plurality of fixed drums of the skew drum arrangement (11) such that the respective skew drum receives the fabric web from a fixed drum, and/or wherein the at least two skew drums (27) and the plurality of fixed drums (43, 45) of the skew drum arrangement (11) are arranged **in that** the fabric web is deflected in a sinus like manner.

6. The weft straightener (1) according to one of the preceding claims,
characterised in that
the drums of the bow drum arrangement (9) and of the skew drum arrangement (11) are arranged **in that** the fabric web is deflected in a sinus like manner along or against a first direction through the bow drum arrangement (9) and through the skew drum arrangement (11), wherein the bow drum arrangement (9) and the skew drum arrangement (11) are arranged next to each other in a second direction extending orthogonal to the first direction.

7. The weft straightener (1) according to claim 6, **characterised in that** the at least two fixed drums (47) are mounted in web-running direction in between the bow drum arrangement (9) and the skew drum ar-

rangement (11) and are spaced from each other in the first direction **in that** the fabric web is in web-running direction first deflected through one of the drum arrangement along the first direction, subsequently over the two fixed drums against the first direction and finally through the other of the drum arrangements along the first direction.

8. The weft straightener according to one of the preceding claims,
characterised in that
the at least two fixed drums are spaced from each other by at least 3, 5 or 7 times the diameter of the bow drums and/or of the skew drums.

9. The weft straightener according to one of the preceding claims,
characterised in that the at least two bow drums are arranged in a bow drum plane (59) and the at least two skew drums are arranged in a skew drum plane (57), wherein the bow drum plane (59) and the skew drum plane (57) extend substantially parallel to each other, wherein substantially parallel encompasses a deviation relative to a parallel alignment of maximally 30°, 20°, 10°, 5°, 3° or 1°.

10. The weft straightener according to claim 9,
characterised in that
the bow drum plain (59) and the skew drum plain (57) are spaced from each other by at least 6, 7, 8 or 9 times the diameter of the skew drums (27) and/or of the bow drums (15).

11. The weft straightener (1) according to claim 9 or 10,
characterised in that
fixed drums (15, 17) of the bow drum arrangement (9) are arranged along a bow drum arrangement fixed drum plain (51), and **in that** fixed drums (43, 45) of the skew drum arrangement (11) are arranged along a skew drum arrangement fixed drum plain (55), wherein the bow drum arrangement fixed drum plain (51) and the skew drum arrangement fixed drum plain (55) extend substantially parallel to the bow drum plane (59) and to the skew drum plane (57).

12. A method for straightening a fabric web in a fabric web manufacturing line, comprising the step of:

conveying the fabric web (7) over a bow drum arrangement (9) comprising at least two bow drums (13), a skew drum arrangement (11) comprising at least two skew drums (27), and at least two fixed drums (47), wherein the fabric web (7) is conveyed in web running direction (W) first over the at least two bow drums (13) and subsequently over the at least two skew drums (27) or vice versa,
wherein
the fabric web (7) is in web-running direction deflected by the at least two fixed drums (47) before being delivered from the at least two bow drums (13) to the at least two skew drums (27) or vice versa.

13. The method according to claim 12, **characterized by** conveying the fabric web (7) over at least one of the at least two bow drums (13) and over a plurality of fixed drums (13, 19) such that the at least one bow drum (13) directly receives the fabric web from one fixed drum and directly delivers the fabric web to one fixed drum.

14. The method according to claim 12 or 13, **characterized by** conveying the fabric web (7) over at least one of the at least two skew drums (27) and over a plurality of fixed drums (43, 45) such that the at least one skew drum directly receives the fabric web from one fixed drum and directly delivers the fabric web to one fixed drum.

15. The method according to one of the claims 12 to 14, **characterized by** conveying the fabric web in a sinus like manner along or against a first direction through the bow drum arrangement (9) and the skew drum arrangement (11), wherein the fabric web (7) is conveyed through the two drum arrangement along separate sinus like paths being located next to each other in a second direction extending orthogonal to the first direction.

16. The method according to one of the claims 12 to 15, **characterized by** adjusting the inclination of the weft yarns (71) of the fabric web in a weft angle of at least 1° and of maximally 30°, in particular of at least 2° and maximally 20°, relative to a theoretical weft yarn direction extending orthogonal to the warp yarn direction.

Patentansprüche

1. Schussfadenrichter (1) für eine Stoffbahnverarbeitungsanlage, umfassend:

- eine Bogenwalzenanordnung (9), die mindestens zwei Bogenwalzen (13) umfasst;
- eine Schrägwalzenanordnung (11), die mindestens zwei Schrägwalzen (27) umfasst,
- mindestens zwei feststehende Walzen (47),
dadurch gekennzeichnet, dass
die Bogenwalzenanordnung (9) und die Schrägwalzenanordnung (11) in Bahnlaufrichtung (W) hintereinander angeordnet sind, so dass eine Stoffbahn zuerst von den mindestens zwei Bogenwalzen (13) und anschließend von den min-

destens zwei Schrägwalzen (27) oder umgekehrt umgelenkt wird; und dass
die mindestens zwei feststehenden Walzen (47) in Bahnlaufrichtung zwischen der mindestens einen Bogenwalzenanordnung (9) und der mindestens einen Schrägwalzenanordnung (11) angeordnet sind, so dass die Stoffbahn von den mindestens zwei feststehenden Walzen (47) umgelenkt wird, bevor sie von der mindestens einen Bogenwalzenanordnung (9) an die mindestens eine Schrägwalzenanordnung (11) oder umgekehrt abgegeben wird.

2. Schussfadenrichter nach Anspruch 1, **dadurch gekennzeichnet, dass** die Bogenwalzenanordnung (9) umfasst:

- eine Mehrzahl von feststehenden Walzen (15, 17), wobei

mindestens eine der mindestens zwei Bogenwalzen (13) in Bahnlaufrichtung (W) zwischen zwei der Mehrzahl von feststehenden Walzen (15, 17) angeordnet ist, so dass sie die Stoffbahn (7) von einer feststehenden Walze aufnimmt und die Stoffbahn an eine feststehende Walze abgibt.

3. Schussfadenrichter nach Anspruch 2, **dadurch gekennzeichnet, dass** jede der mindestens zwei Bogenwalzen (13) der Bogenwalzenanordnung (9), insbesondere jede von mindestens drei Bogenwalzen, in Bahnlaufrichtung (W) oberhalb einer der Mehrzahl von feststehenden Walzen (15, 17) der Bogenwalzenanordnung (9) angeordnet ist, so dass die jeweilige Bogenwalze die Stoffbahn (7) an eine feststehende Walze abgibt, und/oder in Bahnlaufrichtung unterhalb einer der Mehrzahl von feststehenden Walzen der Bogenwalzenanordnung (9) angeordnet ist, so dass die jeweilige Bogenwalze die Stoffbahn von einer feststehenden Walze aufnimmt, und/oder wobei die mindestens zwei Bogenwalzen (13) und die Mehrzahl von feststehenden Walzen (15, 17) der Bogenwalzenanordnung (9) so angeordnet sind, dass die Stoffbahn sinusförmig umgelenkt wird.

4. Schussfadenrichter nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Schrägwalzenanordnung (11) umfasst:

- eine Mehrzahl von feststehenden Walzen (43, 45), wobei mindestens eine der mindestens zwei Schrägwalzen (27) in Bahnlaufrichtung (W) zwischen zwei der Mehrzahl von feststehenden Walzen (43, 45) angeordnet ist, so dass sie die Stoffbahn (7) von einer feststehenden Walze aufnimmt und die Stoffbahn an eine feststehende Walze abgibt.

5. Schussfadenrichter nach Anspruch 4, **dadurch gekennzeichnet, dass** jede der mindestens zwei Schrägwalzen (27), insbesondere jede von mindestens drei Schrägwalzen, in Bahnlaufrichtung (W) oberhalb einer der Mehrzahl von feststehenden Walzen (43, 45) der Schrägwalzenanordnung (11) angeordnet ist, so dass die jeweilige Schrägwalze die Stoffbahn (7) an eine feststehende Walze abgibt, und/oder in Bahnlaufrichtung unterhalb einer der Mehrzahl von feststehenden Walzen der Schrägwalzenanordnung (11) angeordnet ist, so dass die jeweilige Schrägwalze die Stoffbahn von einer feststehenden Walze aufnimmt, und/oder wobei die mindestens zwei Schrägwalzen (27) und die Mehrzahl von feststehenden Walzen (43, 45) der Schrägwalzenanordnung (11) so angeordnet sind, dass die Stoffbahn sinusförmig umgelenkt wird.

6. Schussfadenrichter (1) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Walzen der Bogenwalzenanordnung (9) und der Schrägwalzenanordnung (11) so angeordnet sind, dass die Stoffbahn entlang oder entgegen einer ersten Richtung durch die Bogenwalzenanordnung (9) und durch die Schrägwalzenanordnung (11) sinusförmig umgelenkt wird, wobei die Bogenwalzenanordnung (9) und die Schrägwalzenanordnung (11) in einer zweiten, orthogonal zur ersten Richtung verlaufenden Richtung nebeneinander angeordnet sind.

7. Schussfadenrichter (1) nach Anspruch 6, **dadurch gekennzeichnet, dass** die mindestens zwei feststehenden Walzen (47) in Bahnlaufrichtung zwischen der Bogenwalzenanordnung (9) und der Schrägwalzenanordnung (11) angeordnet und in der ersten Richtung voneinander beabstandet sind, so dass die Stoffbahn in Bahnlaufrichtung zuerst durch eine der Walzenanordnungen entlang der ersten Richtung, anschließend über die beiden feststehenden Walzen entgegen der ersten Richtung und schließlich durch die andere der Walzenanordnungen entlang der ersten Richtung umgelenkt wird.

8. Schussfadenrichter nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die mindestens zwei feststehenden Walzen mindestens um das 3-, 5- oder 7-fache des Durchmessers der Bogenwalzen und/oder der Schrägwalzen voneinander beabstandet sind.

9. Schussfadenrichter nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die mindestens zwei Bogenwalzen in einer Bogenwalzenebene (59) und die mindestens zwei Schrägwalzen in einer Schrägwalzenebene (57) angeordnet sind, wobei die Bogenwalzenebene (59) und die Schrägwalzenebene (57) im Wesentlichen parallel

zueinander verlaufen, wobei im Wesentlichen parallel eine Abweichung gegenüber einer parallelen Ausrichtung von maximal 30°, 20°, 10°, 5°, 3° oder 1° umfasst.

10. Schussfadenrichter nach Anspruch 9, **dadurch gekennzeichnet, dass** die Bogenwalzenebene (59) und die Schrägwalzenebene (57) mindestens um das 6-, 7-, 8- oder 9-fache des Durchmessers der Schrägwalzen (27) und/oder der Bogenwalzen (15) voneinander beabstandet sind.

11. Schussfadenrichter (1) nach Anspruch 9 oder 10, **dadurch gekennzeichnet, dass** feststehende Walzen (15, 17) der Bogenwalzenanordnung (9) entlang einer Ebene (51) von feststehenden Walzen der Bogenwalzenanordnung angeordnet sind, und dass feststehende Walzen (43, 45) der Schrägwalzenanordnung (11) entlang einer Ebene (55) von feststehenden Walzen der Schrägwalzenanordnung angeordnet sind, wobei die Ebene (51) von feststehenden Walzen der Bogenwalzenanordnung und die Ebene (55) von feststehenden Walzen der Schrägwalzenanordnung im Wesentlichen parallel zur Bogenwalzenebene (59) und zur Schrägwalzenebene (57) verlaufen.

12. Verfahren zum Richten einer Stoffbahn in einer Stoffbahnverarbeitungsanlage, die Schritte umfassend:

Fördern der Stoffbahn (7) über eine Bogenwalzenanordnung (9), die mindestens zwei Bogenwalzen (13) umfasst, eine Schrägwalzenanordnung (11), die mindestens zwei Schrägwalzen (27) umfasst, und mindestens zwei feststehende Walzen (47), wobei die Stoffbahn (7) in Bahnlaufrichtung (W) zuerst über die mindestens zwei Bogenwalzen (13) und anschließend über die mindestens zwei Schrägwalzen (27) oder umgekehrt gefördert wird,
wobei die Stoffbahn (7) in Bahnlaufrichtung von den mindestens zwei feststehenden Walzen (47) umgelenkt wird, bevor sie von den mindestens zwei Bogenwalzen (13) an die mindestens zwei Schrägwalzen (27) oder umgekehrt abgegeben wird.

13. Verfahren nach Anspruch 12, **dadurch gekennzeichnet, dass** die Stoffbahn (7) über mindestens eine der mindestens zwei Bogenwalzen (13) und über eine Mehrzahl von feststehenden Walzen (13, 19) gefördert wird, so dass die mindestens eine Bogenwalze (13) die Stoffbahn direkt von einer feststehenden Walze aufnimmt und die Stoffbahn direkt an eine feststehende Walze abgibt.

14. Verfahren nach Anspruch 12 oder 13, **dadurch gekennzeichnet, dass** die Stoffbahn (7) über mindestens eine der mindestens zwei Schrägwalzen (27) und über eine Mehrzahl von feststehenden Walzen (43, 45) gefördert wird, so dass die mindestens eine Schrägwalze die Stoffbahn direkt von einer feststehenden Walze aufnimmt und die Stoffbahn direkt an eine feststehende Walze abgibt.

15. Verfahren nach einem der Ansprüche 12 bis 14, **dadurch gekennzeichnet, dass** die Stoffbahn sinusförmig entlang oder entgegen einer ersten Richtung durch die Bogenwalzenanordnung (9) und die Schrägwalzenanordnung (11) gefördert wird, wobei die Stoffbahn (7) entlang separater sinusförmiger Pfade, die in einer zweiten, orthogonal zur ersten Richtung verlaufenden Richtung nebeneinander angeordnet sind, durch die beiden Walzenanordnungen gefördert wird.

16. Verfahren nach einem der Ansprüche 12 bis 15, **dadurch gekennzeichnet, dass** die Neigung der Schussfäden (71) der Stoffbahn in einem Schusswinkel von mindestens 1° und maximal 30°, insbesondere von mindestens 2° und maximal 20°, relativ zu einer theoretischen, orthogonal zur Kettfadenrichtung verlaufenden Schussfadenrichtung eingestellt werden.

Revendications

1. Redresseur de trame (1) pour ligne de fabrication de bandes de tissu, comprenant :

- un dispositif de tambours d'archet (9) comprenant au moins deux tambours d'archet (13) ;
- un dispositif de tambours obliques (11) comprenant au moins deux tambours obliques (27) ;
- au moins deux tambours fixes (47), **caractérisé en ce que** le dispositif de tambours d'archet (9) et le dispositif de tambours obliques (11) sont, dans le sens de circulation de la bande (W), disposés successivement de manière à ce qu'une bande de tissu soit d'abord déviée par les au moins deux tambours d'archet (13) et ensuite par les au moins deux tambours obliques (27) ou vice versa ; et

en ce que les au moins deux tambours fixes (47) se trouvent, dans le sens de circulation de la bande, dans l'intervalle entre l'au moins un dispositif de tambours d'archet (9) et l'au moins un dispositif de tambours obliques (11) de manière à ce que la bande de tissu soit déviée par les au moins deux tambours fixes (47) avant d'être délivrée depuis l'au moins un dispositif de tambours d'archet (9) vers l'au moins un dispositif de tambours obliques (11) ou vice versa.

2. Redresseur de trame selon la revendication 1, **ca-**

ractérisé en ce que le dispositif de tambours d'archet (9) comprend :

- une pluralité de tambours fixes (15, 17),

au moins un des au moins deux tambours d'archet (13) se trouvant, dans le sens de circulation de la bande (W), dans l'intervalle entre deux de la pluralité de tambours fixes (15, 17) de manière à recevoir la bande de tissu (7) en provenance d'un tambour fixe et à délivrer la bande de tissu à un tambour fixe.

3. Redresseur de trame selon la revendication 2, **caractérisé en ce que** chacun des au moins deux tambours d'archet (13) du dispositif de tambours d'archet (9), en particulier chacun d'au moins trois tambours d'archet, se trouve, dans le sens de circulation de la bande (W), vers le haut de la pluralité de tambours fixes (15, 17) du dispositif de tambours d'archet (9), de sorte que le tambour d'archet respectif délivre la bande de tissu (7) à un tambour fixe et/ou se trouve, dans le sens de circulation de la bande, vers le bas de l'un de la pluralité de tambours fixes du dispositif de tambours d'archet (9), de sorte que le tambour d'archet respectif reçoit la bande de tissu en provenance d'un tambour fixe, et/ou les au moins deux tambours d'archet (13) et que la pluralité de tambours fixes (15, 17) du dispositif de tambours d'archet (9) sont disposés de manière à ce que la bande de tissu soit déviée de manière sinusoïdale.

4. Redresseur de trame selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le dispositif de tambours obliques (11) comprend :

- une pluralité de tambours fixes (43, 45), au moins un des au moins deux tambours obliques (27) se trouvant, dans le sens de circulation de la bande (W), dans l'intervalle entre deux de la pluralité de tambours fixes (43, 45) de manière à recevoir la bande de tissu (7) en provenance d'un tambour fixe et à délivrer la bande de tissu à un tambour fixe.

5. Redresseur de trame selon la revendication 4, **caractérisé en ce que** chacun des au moins deux tambours obliques (27), en particulier chacun des au moins trois tambours obliques, se trouve, dans le sens de circulation de la bande (W), vers le haut de l'un de la pluralité de tambours fixes (43, 45) du dispositif de tambours obliques (11), de sorte que le tambour fixe respectif délivre la bande de tissu (7) à un tambour fixe et/ou se trouve, dans le sens de circulation de la bande, vers le bas de l'un de la pluralité de tambours fixes du dispositif de tambours obliques (11), de sorte que le tambour oblique respectif reçoit la bande de tissu en provenance d'un tambour fixe, et/ou les au moins deux tambours obliques (27) et que la pluralité de tambours fixes (43, 45) du dispositif de tambours obliques (11) sont disposés de manière à ce que la bande de tissu soit déviée de manière sinusoïdale.

6. Redresseur de trame (1) selon l'une quelconque des revendications précédentes, **caractérisé en ce que** les tambours du dispositif de tambours d'archet (9) et du dispositif de tambours obliques (11) sont disposés de manière à ce que la bande de tissu soit déviée de manière sinusoïdale dans un sens ou à l'encontre d'un premier sens à travers le dispositif de tambours d'archet (9) et à travers le dispositif de tambours obliques (11), le dispositif de tambours d'archet (9) et le dispositif de tambours obliques (11) étant disposés près de l'autre dans un second sens s'étendant orthogonalement au premier sens.

7. Redresseur de trame (1) selon la revendication 6, **caractérisé en ce que** les au moins deux tambours fixes (47) sont montés, dans le sens de circulation de la bande, dans l'intervalle entre le dispositif de tambours d'archet (9) et le dispositif de tambours obliques (11) et sont espacés l'un de l'autre dans le premier sens par le fait que la bande de tissu est, dans le sens de circulation de la bande, d'abord déviée à travers l'un des dispositifs de tambours dans le premier sens, ensuite sur les deux tambours fixes à l'encontre du premier sens et finalement à travers l'autre des dispositifs de tambours dans le premier sens.

8. Redresseur de trame selon l'une quelconque des revendications précédentes, **caractérisé en ce que** les au moins deux tambours fixes sont espacés l'un de l'autre à raison d'au moins 3,5 à 7 fois le diamètre des tambours d'archet et/ou des tambours obliques.

9. Redresseur de trame selon l'une quelconque des revendications précédentes, **caractérisé en ce que** les au moins deux tambours d'archet sont disposés dans un plan de tambours d'archet (59) et les au moins deux tambours obliques sont disposés dans un plan de tambours obliques (57), le plan de tambours d'archet (59) et le plan de tambours obliques (57) s'étendant sensiblement parallèlement l'un à l'autre, sensiblement parallèlement incluant une déviation par rapport à un alignement parallèle de 30°, 20°, 10°, 5°, 3° ou 1° au maximum.

10. Redresseur de trame selon la revendication 9, **caractérisé en ce que** le plan de tambours d'archet (59) et le plan de tambours obliques (57) sont espacés l'un de l'autre à raison d'au moins 6, 7, 8 ou 9 fois le diamètre des tambours obliques (27) et/ou des tambours d'archet (15).

11. Redresseur de trame (1) selon la revendication 9 ou

10, **caractérisé en ce que** des tambours fixes (15, 17) du dispositif de tambours d'archet (9) sont disposés le long d'un plan de tambours fixes de dispositif de tambours d'archet (51), et **en ce que** des tambours fixes (43, 45) du dispositif de tambours obliques (11) sont disposés le long d'un plan de tambours fixes du dispositif de tambours obliques (55), le plan de tambours fixes du dispositif de tambours d'archet (51) et le plan de tambours fixes du dispositif de tambours obliques (55) s'étendant sensiblement parallèlement au plan de tambours d'archet (59) et au plan de tambours obliques (57).

12. Procédé de redressement d'une bande de tissu dans une ligne de fabrication de bandes de tissu, comprenant les étapes suivantes :

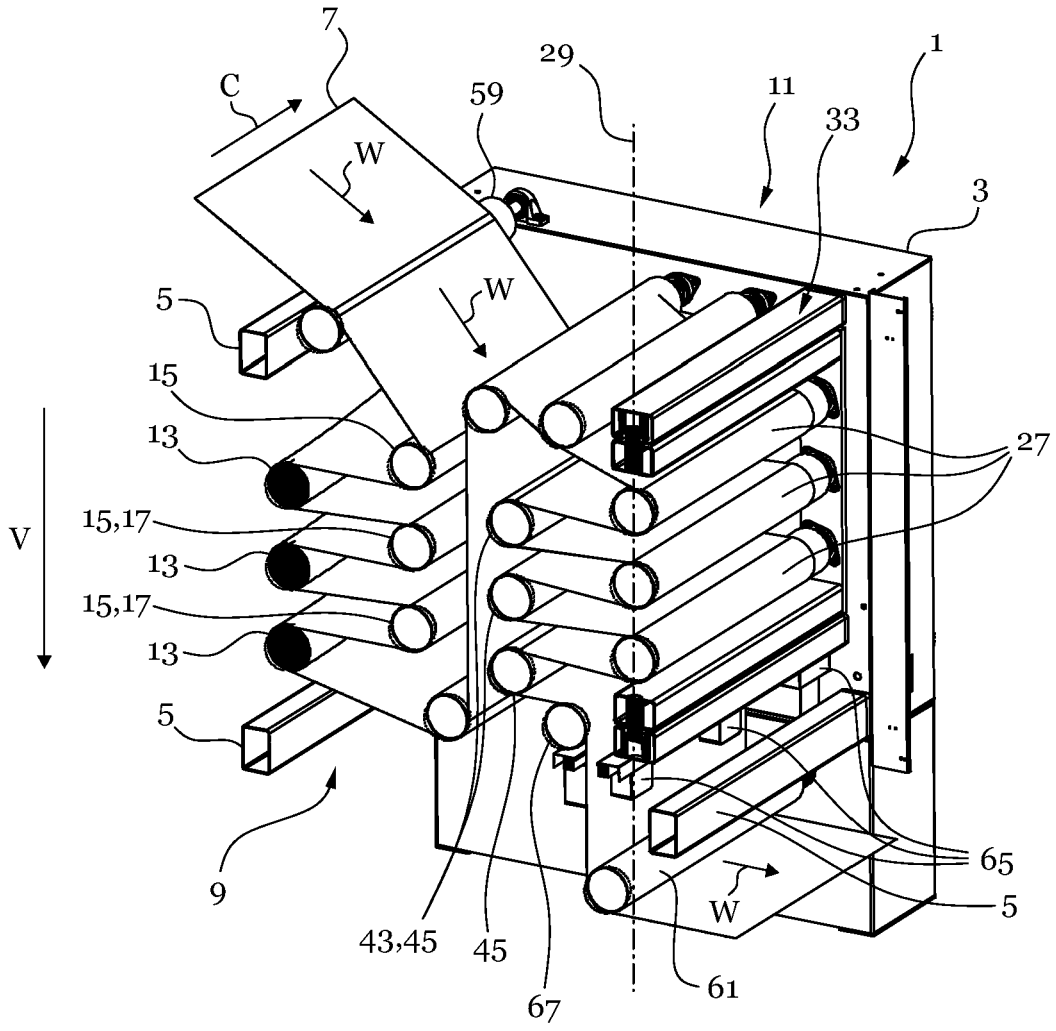
convoyage de la bande de tissu (7) sur un dispositif de tambours d'archet (9) comprenant au moins deux tambours d'archet (13), un dispositif de tambours obliques (11) comprenant au moins deux tambours obliques (27) et au moins deux tambours fixes (47), la bande de tissu (7) étant convoyée, dans le sens de circulation de la bande (W), d'abord sur les au moins deux tambours d'archet (13) et ensuite sur les au moins deux tambours obliques (27) ou vice versa,
la bande de tissu (7) étant, dans le sens de circulation de la bande, déviée par les au moins deux tambours fixes (47) avant d'être délivrée depuis les au moins deux tambours d'archet (13) vers les au moins deux tambours obliques (27) ou vice versa.

13. Procédé selon la revendication 12, **caractérisé par** le convoyage de la bande de tissu (7) sur au moins l'un des deux tambours d'archet (13) et sur une pluralité de tambours fixes (13, 19), de manière à ce que l'au moins un tambour d'archet (13) reçoive directement la bande de tissu depuis un tambour fixe et délivre directement la bande de tissu à un tambour fixe.

14. Procédé selon la revendication 12 ou 13, **caractérisé par** le convoyage de la bande de tissu (7) sur au moins l'un des au moins deux tambours obliques (27) et sur une pluralité de tambours fixes (43, 45) de manière à ce que l'au moins un tambour oblique reçoive directement la bande de tissu en provenance d'un tambour fixe et délivre directement la bande de tissu à un tambour fixe.

15. Procédé selon l'une quelconque des revendications 12 à 14, **caractérisé par** le convoyage de la bande de tissu de manière sinusoïdale dans ou à l'encontre d'un premier sens à travers le dispositif de tambours d'archet (9) et le dispositif de tambours obliques (11), la bande de tissu (7) étant convoyée à travers les deux dispositifs de tambours le long de parcoure sinusoïdaux séparés qui se trouvent à proximité les uns des autres ou dans un second sens étendant orthogonalement au premier sens.

16. Procédé selon l'une quelconque des revendications 12 à 15, **caractérisé par** le réglage de l'inclinaison des fils de trame (71) de la bande de tissu suivant un angle de trame d'au moins 1° et au maximum de 30°, en particulier d'au moins 2° et au maximum de 20°, par rapport à un sens de fils de trame théorique s'étendant orthogonalement au sens de fils de trame.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C
29
1
59
11
33
W
3
W
5
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27
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15,17
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5
9
65
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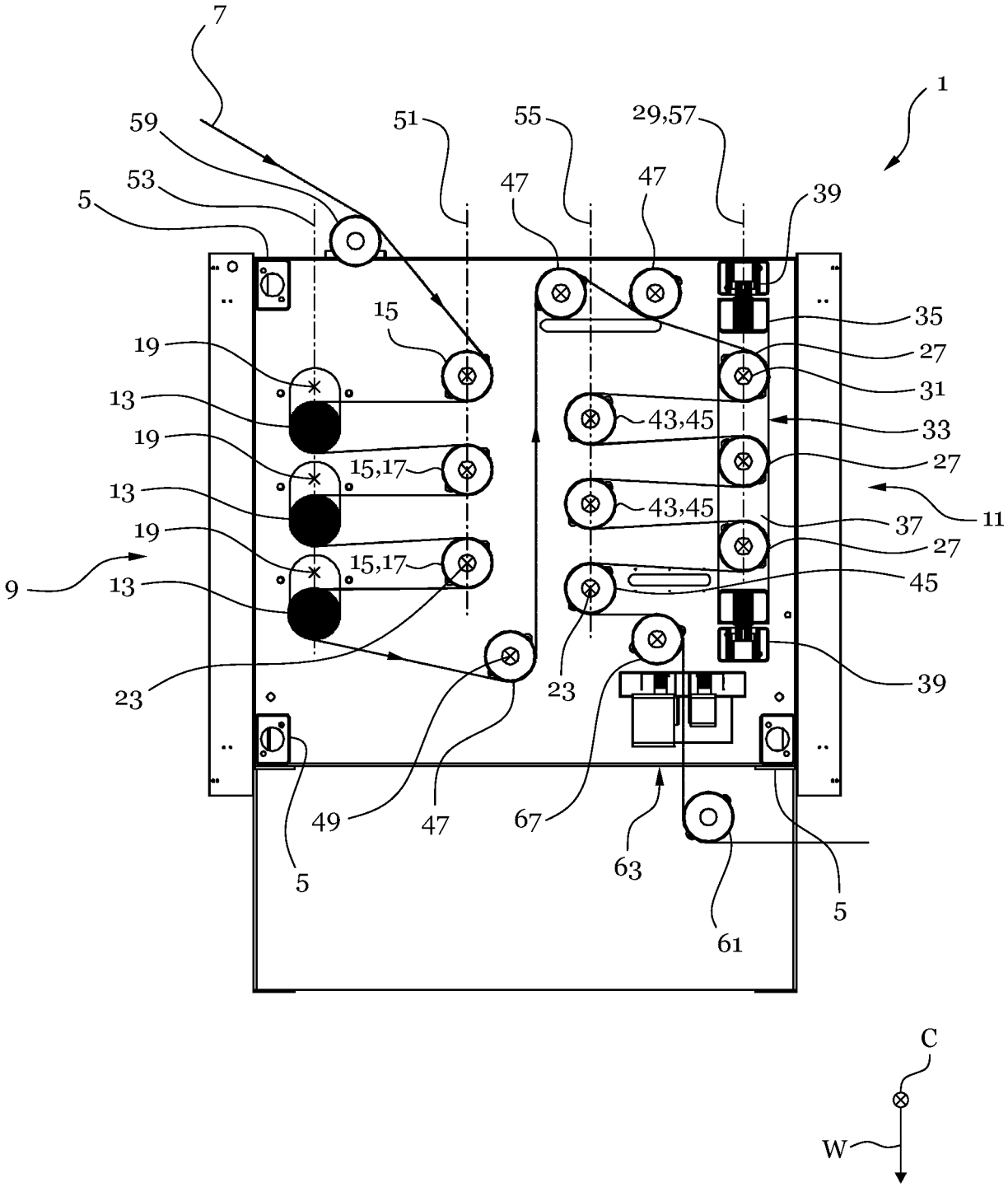
W
43,45
45
67
61

Fig. 1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C
W

Fig. 2

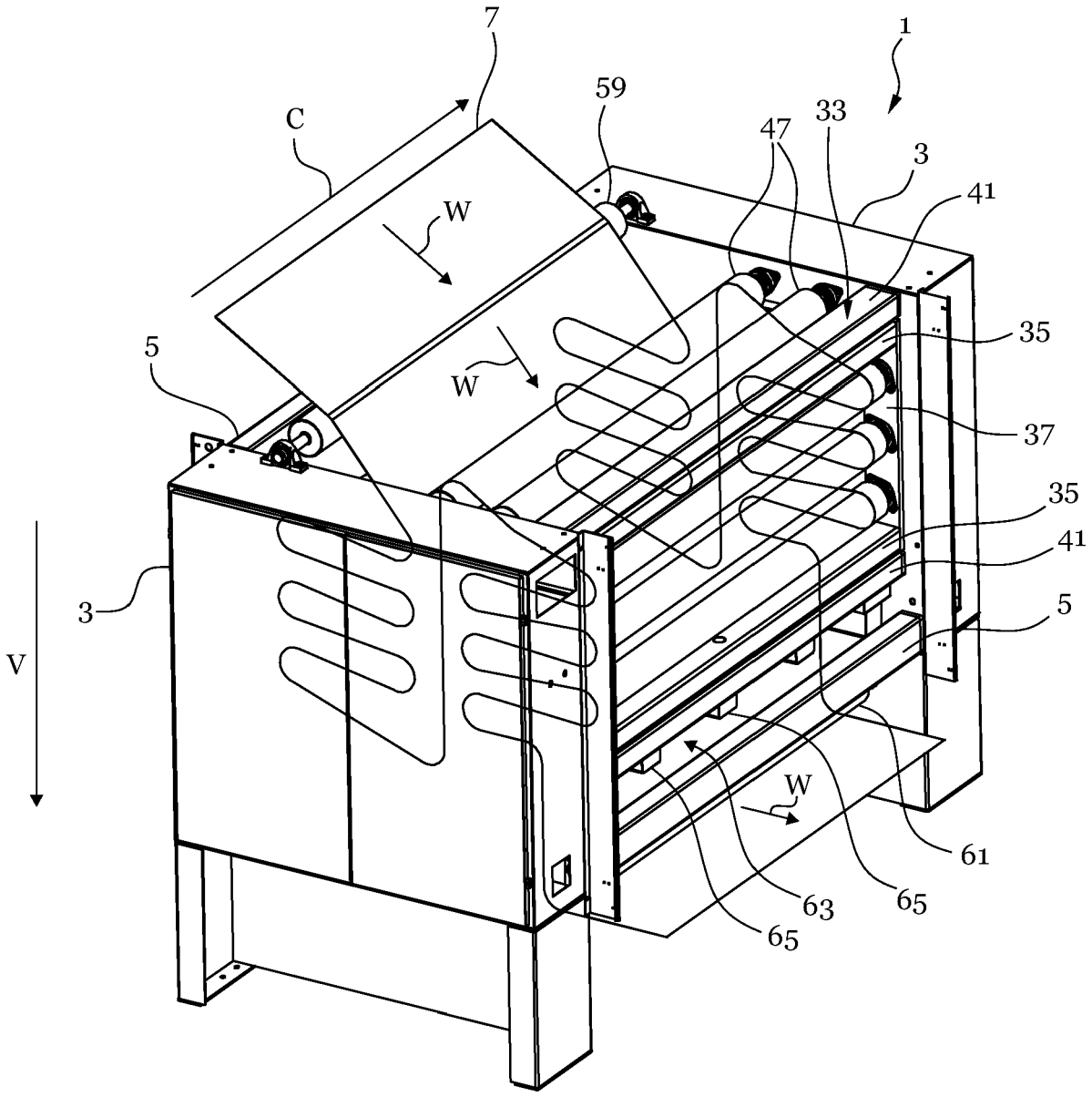

Fig. 3

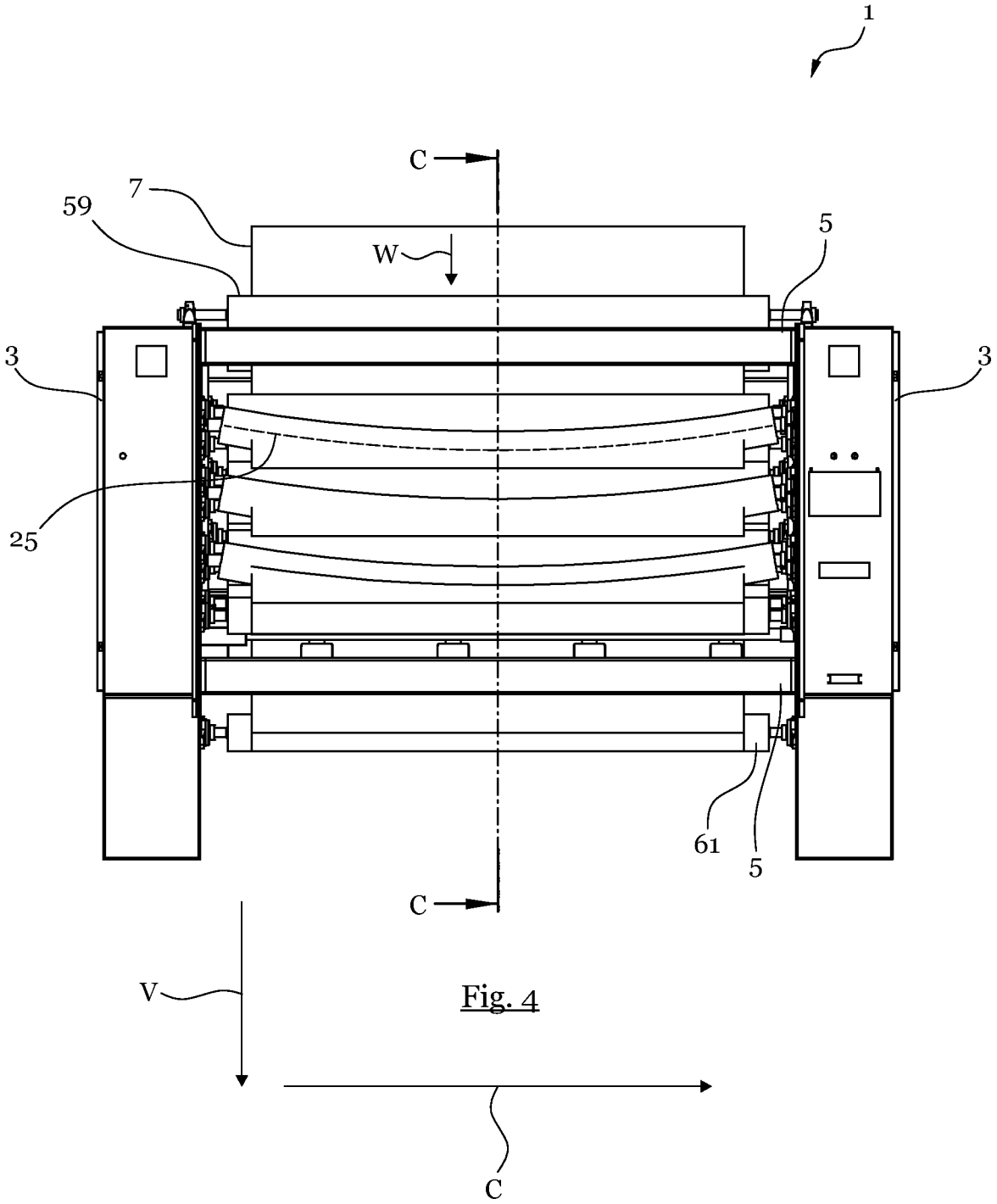

Fig. 4

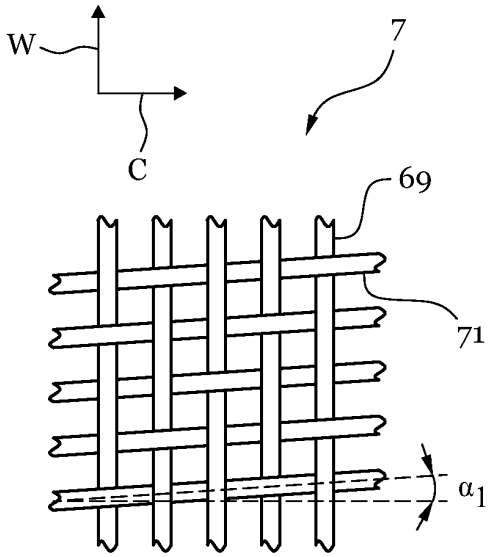

Fig. 5a

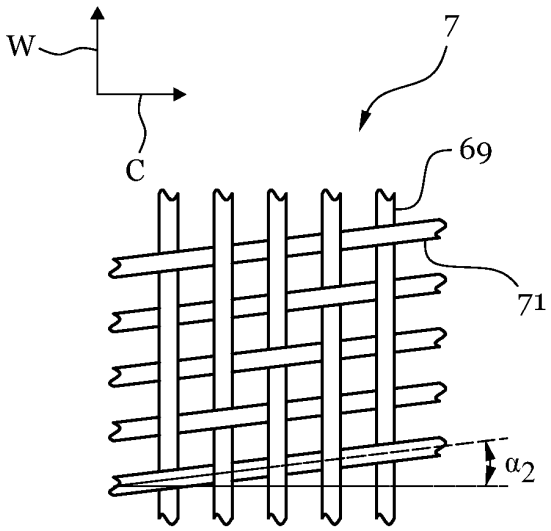

Fig. 5b

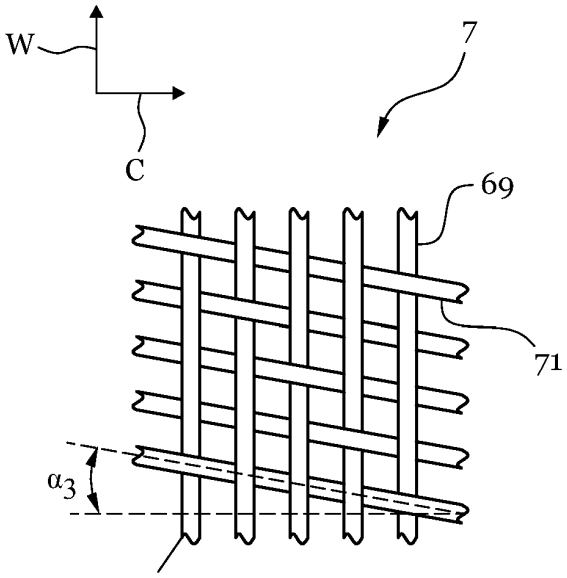

Fig. 5c

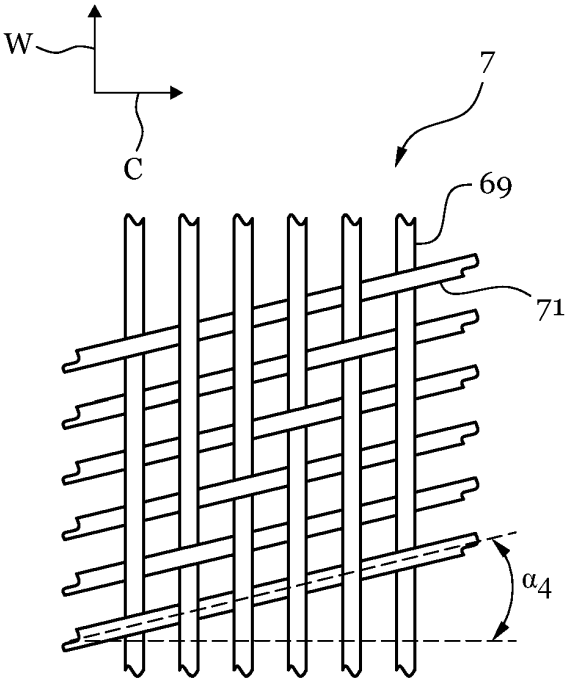

Fig. 5d

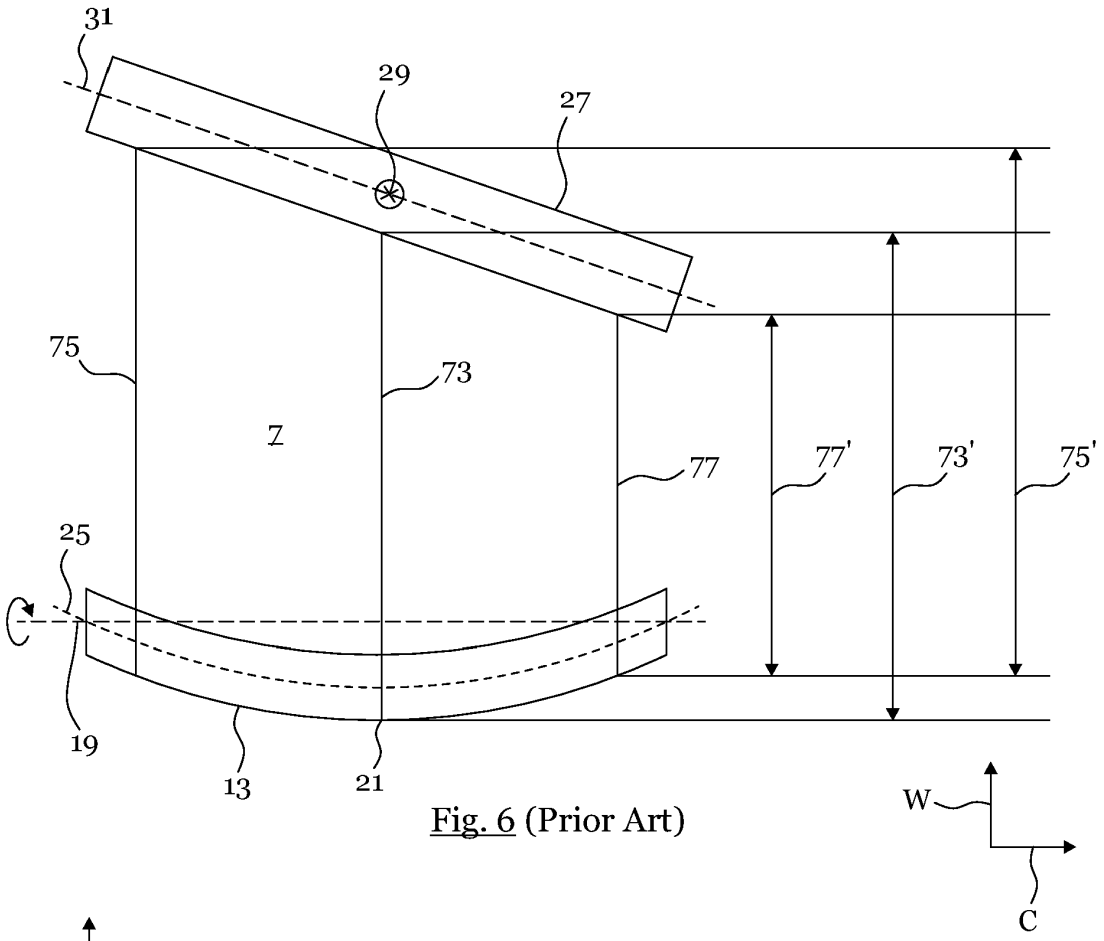

Fig. 6 (Prior Art)

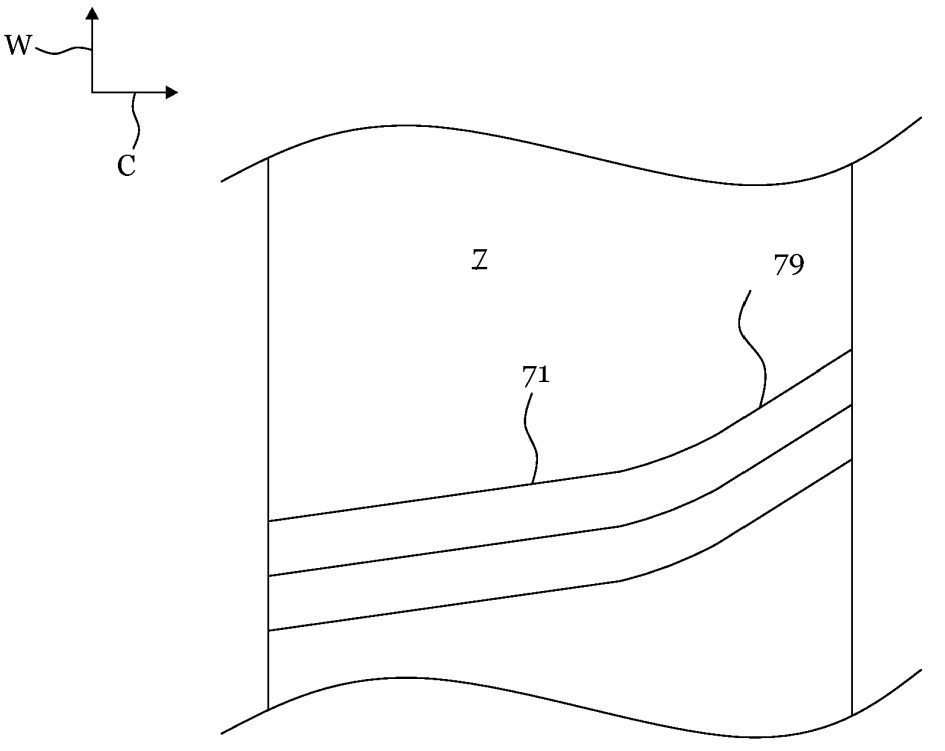

Fig. 7 (Prior Art)

REFERENCES CITED IN THE DESCRIPTION

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