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

(11) EP 1 067 238 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
10.01.2001 Bulletin 2001/02

(51) Int Cl.[7]: **D21F 7/08**

(21) Application number: **00850126.4**

(22) Date of filing: **06.07.2000**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **09.07.1999 US 350711**

(71) Applicant: **ALBANY INTERNATIONAL CORP.**
Albany, New York 12204 (US)

(72) Inventor: **Joyce, Michael J.**
Clifton Park, New York 12065 (US)

(74) Representative: **Giver, Sören Bo et al**
Awapatent AB,
P.O. Box 5117
200 71 Malmö (SE)

(54) Multi-axial press fabric

(57) A multi-axial press fabric includes a base fabric and several layers of staple fiber material attached to the base fabric by needling. The base fabric has at least one layer assembled by spirally winding a woven fabric strip. The base fabric takes the form of an endless loop. The yarns of the woven fabric strip accordingly lie in directions different from the machine- and cross-machine directions of the base fabric, giving the base fabric multi-axial characteristics. Individual fibers in the several layers of staple fiber material attached to the base fabric are predominantly oriented at oblique angles relative to the machine direction of the press fabric. More specifically, they form a crisscrossed angular web.

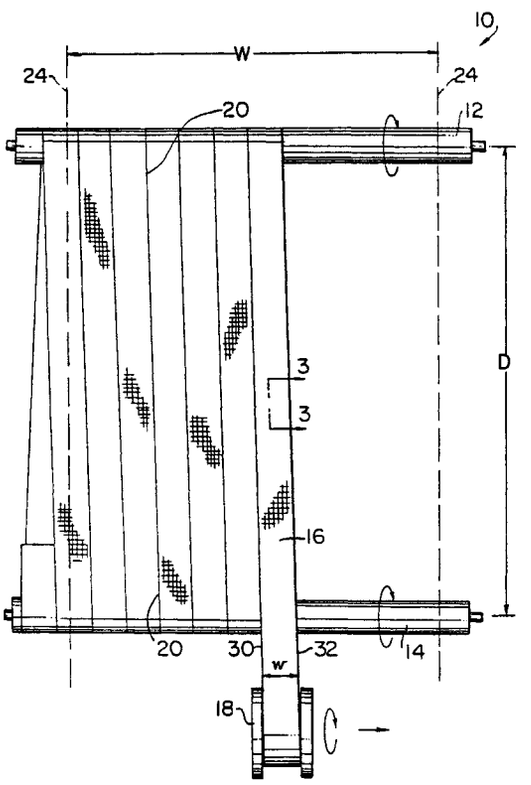

FIG.1

EP 1 067 238 A2

Description

Background of the Invention

1. Field of the Invention

[0001] The present invention relates to the papermaking arts. More specifically, the present invention relates to press fabrics for the press section of a paper machine.

2. Description of the Prior Art

[0002] During the papermaking process, a cellulosic fibrous web is formed by depositing a fibrous slurry, that is, an aqueous dispersion of cellulose fibers, onto a moving forming fabric in the forming section of a paper machine. A large amount of water is drained from the slurry through the forming fabric, leaving the cellulosic fibrous web on the surface of the forming fabric.

[0003] The newly formed cellulosic fibrous web proceeds from the forming section to a press section, which includes a series of press nips. The cellulosic fibrous web passes through the press nips supported by a press fabric, or, as is often the case, between two such press fabrics. In the press nips, the cellulosic fibrous web is subjected to compressive forces which squeeze water therefrom, and which adhere the cellulosic fibers in the web to one another to turn the cellulosic fibrous web into a paper sheet. The water is accepted by the press fabric or fabrics and, ideally, does not return to the paper sheet.

[0004] The paper sheet finally proceeds to a dryer section, which includes at least one series of rotatable dryer drums or cylinders, which are internally heated by steam. The newly formed paper sheet is directed in a serpentine path sequentially around each in the series of drums by a dryer fabric, which holds the paper sheet closely against the surfaces of the drums. The heated drums reduce the water content of the paper sheet to a desirable level through evaporation.

[0005] It should be appreciated that the forming, press and dryer fabrics all take the form of endless loops on the paper machine and function in the manner of conveyors. It should further be appreciated that paper manufacture is a continuous process which proceeds at considerable speeds. That is to say, the fibrous slurry is continuously deposited onto the forming fabric in the forming section, while a newly manufactured paper sheet is continuously wound onto rolls after it exits from the dryer section.

[0006] The present invention relates specifically to the press fabrics used in the press section. Press fabrics play a critical role during the paper manufacturing process. One of their functions, as implied above, is to support and to carry the paper product being manufactured through the press nips.

[0007] Press fabrics also participate in the finishing of the surface of the paper sheet. That is, press fabrics are designed to have smooth surfaces and uniformly resilient structures, so that, in the course of passing through the press nips, a smooth, mark-free surface is imparted to the paper.

[0008] Perhaps most importantly, the press fabrics accept the large quantities of water extracted from the wet paper in the press nip. In order to fill this function, there literally must be space, commonly referred to as void volume, within the press fabric for the water to go, and the fabric must have adequate permeability to water for its entire useful life. Finally, press fabrics must be able to prevent the water accepted from the wet paper from returning to and rewetting the paper upon exit from the press nip.

[0009] Contemporary press fabrics are produced in a wide variety of styles designed to meet the requirements of the paper machines on which they are installed for the paper grades being manufactured. Generally, they comprise a woven base fabric into which has been needled a batt of fine, nonwoven fibrous material. The base fabrics may be woven from monofilament, plied monofilament, multifilament or plied multifilament yarns, and may be single-layered, multi-layered or laminated. The yarns are typically extruded from any one of the synthetic polymeric resins, such as polyamide and polyester resins, used for this purpose by those of ordinary skill in the paper machine clothing arts.

[0010] The woven base fabrics themselves take many different forms. For example, they may be woven endless, or flat woven and subsequently rendered into endless form with a woven seam. Alternatively, they may be produced by a process commonly known as modified endless weaving, wherein the widthwise edges of the base fabric are provided with seaming loops using the machine-direction (MD) yarns thereof. In this process, the MD yarns weave continuously back-and-forth between the widthwise edges of the fabric, at each edge turning back and forming a seaming loop. A base fabric produced in this fashion is placed into endless form during installation on a papermachine, and for this reason is referred to as an on-machine-seamable fabric. To place such a fabric into endless form, the two widthwise edges are brought together, the seaming loops at the two edges are interdigitated with one another, and a seaming pin or pintle is directed through the passage formed by the interdigitated seaming loops.

[0011] Further, the woven base fabrics may be laminated by placing one base fabric within the endless loop formed by another, and by needling a staple fiber batt through both base fabrics to join them to one another. One or both woven base fabrics may be of the on-machine-seamable type.

[0012] In any event, the woven base fabrics are in the form of endless loops, or are seamable into such forms, having a specific length, measured longitudinally thereabout, and a specific width, measured transversely thereacross. Because paper machine configurations vary widely, paper machine clothing manufacturers are

required to produce press fabrics, and other paper machine clothing, to the dimensions required to fit particular positions in the paper machines of their customers. Needless to say, this requirement makes it difficult to streamline the manufacturing process, as each press fabric must typically be made to order.

[0013] In response to this need to produce press fabrics in a variety of lengths and widths more quickly and efficiently, press fabrics have been produced in recent years using a spiral technique disclosed in commonly assigned U.S. Patent No. 5,360,656 to Rexfelt et al., the teachings of which are incorporated herein by reference.

[0014] U.S. Patent No. 5,360,656 shows a press fabric comprising a base fabric having one or more layers of staple fiber material needled thereinto. The base fabric comprises at least one layer composed of a spirally wound strip of woven fabric having a width which is smaller than the width of the base fabric. The base fabric is endless in the longitudinal, or machine, direction. Lengthwise threads of the spirally wound strip make an angle with the longitudinal direction of the press fabric. The strip of woven fabric may be flat-woven on a loom which is narrower than those typically used in the production of paper machine clothing.

[0015] The base fabric comprises a plurality of spirally wound and joined turns of the relatively narrow woven fabric strip. The fabric strip is woven from lengthwise (warp) and crosswise (filling) yarns. Adjacent turns of the spirally wound fabric strip may be abutted against one another, and the helically continuous seam so produced may be closed by sewing, stitching, melting or welding. Alternatively, adjacent longitudinal edge portions of adjoining spiral turns may be arranged overlappingly, so long as the edges have a reduced thickness, so as not to give rise to an increased thickness in the area of the overlap. Further, the spacing between lengthwise yarns may be increased at the edges of the strip, so that, when adjoining spiral turns are arranged overlappingly, there may be an unchanged spacing between lengthwise threads in the area of the overlap.

[0016] In any case, a woven base fabric, taking the form of an endless loop and having an inner surface, a longitudinal (machine) direction and a transverse (cross-machine)) direction, is the result. The lateral edges of the woven base fabric are then trimmed to render them parallel to its longitudinal (machine) direction. The angle between the machine direction of the woven base fabric and the helically continuous seam may be relatively small, that is, typically less than 10°. By the same token, the lengthwise (warp) yarns of the woven fabric strip make the same relatively small angle with the longitudinal (machine) direction of the woven base fabric. Similarly, the crosswise (filling) yarns of the woven fabric strip, being perpendicular to the lengthwise (warp) yarns, make the same relatively small angle with the transverse (cross-machine) direction of the woven base fabric. In short, neither the lengthwise (warp) nor the crosswise (filing) yarns of the woven fabric strip align with the longitudinal (machine) or transverse (cross-machine) directions of the woven base fabric.

[0017] In the method shown in U.S. Patent No. 5,360,656, the woven fabric strip is wound around two parallel rolls to assemble the woven base fabric. It will be recognized that endless base fabrics in a variety of widths and lengths may be provided by spirally winding a relatively narrow piece of woven fabric strip around the two parallel rolls, the length of a particular endless base fabric being determined by the length of each spiral turn of the woven fabric strip, and the width being determined by the number of spiral turns of the woven fabric strip. The prior necessity of weaving complete base fabrics of specified lengths and widths to order may thereby be avoided. Instead, a loom as narrow as 20 inches (0.5 meters) could be used to produce a woven fabric strip, but, for reasons of practicality, a conventional textile loom having a width of from 40 to 60 inches (1.0 to 1.5 meters) may be preferred.

[0018] U.S. Patent No. 5,360,656 also shows a press fabric comprising a base fabric having two layers, each composed of a spirally wound strip of woven fabric. Both layers take the form of an endless loop, one being inside the endless loop formed by the other. Preferably, the spirally wound strip of woven fabric in one layer spirals in a direction opposite to that of the strip of woven fabric in the other layer. That is to say, more specifically, the spirally wound strip in one layer defines a right-handed spiral, while that in the other layer defines a left-handed spiral. In such a two-layer, laminated base fabric, the lengthwise (warp) yarns of the woven fabric strip in each of the two layers make relatively small angles with the longitudinal (machine) direction of the woven base fabric, and the lengthwise (warp) yarns of the woven fabric strip in one layer make an angle with the lengthwise (warp) yarns of the woven fabric strip in the other layer. Similarly, the crosswise (filling) yarns of the woven fabric strip in each of the two layers make relatively small angles with the transverse (cross-machine) direction of the woven base fabric, and the crosswise (filling) yarns of the woven fabric strip in one layer make an angle with the crosswise (filling) yarns of the woven fabric strip in the other layer. In short, neither the lengthwise (warp) nor the crosswise (filling) yarns of the woven fabric strip in either layer align with the longitudinal (machine) or transverse (cross-machine) directions of the base fabric. Further, neither the lengthwise (warp) nor the crosswise (filling) yarns of the woven fabric strip in either layer align with those of the other.

[0019] As a consequence, the base fabrics shown in U.S. Patent No. 5,360,656 have no defined machine- or cross-machine-direction yarns. Instead, the yarn systems lie in directions at oblique angles to the machine and cross-machine directions. A press fabric having such a base fabric may be referred to as a multi-axial press fabric. Whereas the standard press fabrics of the prior art have three axes: one in the machine direction

(MD), one in the cross-machine direction (CD), and one in the Z-direction, which is through the thickness of the fabric, a multi-axial press fabric has not only these three axes, but also has at least two more axes defined by the directions of the yarn systems in its spirally wound layer or layers. Moreover, there are multiple flow paths in the Z-direction of a multi-axial press fabric. As a consequence, a multi-axial press fabric has at least five axes. Because of its multi-axial structure, a multi-axial press fabric having more than one layer exhibits superior resistance to nesting and/or to collapse in response to compression in a press nip during the papermaking process as compared to one having base fabric layers whose yarn systems are parallel to one another.

[0020] The present invention is an improved multi-axial press fabric having a base fabric of the foregoing type and a plurality of layers of staple fiber material needled thereinto. The fibers making up the layers of staple fiber material predominantly lie in directions other than the longitudinal (machine) and transverse (cross-machine) directions of the multi-axial press fabric, and specifically at oblique angles relative to the longitudinal direction, thereby providing a press fabric whose components can all be considered to be multi-axial.

Summary of the Invention

[0021] In its broadest form, the present multi-axial press fabric for the press section of a paper machine comprises a base fabric having at least one layer formed by spirally winding a fabric strip. The fabric strip may be woven from lengthwise yarns and crosswise yarns. Alternatively, the fabric strip may be a nonwoven mesh fabric of the variety disclosed in commonly assigned U. S. Patent No. 4,427,734 to Johnson, the teachings of which are incorporated herein by reference. In either case, the fabric strip has a first lateral edge and a second lateral edge, and is spirally wound in a plurality of contiguous turns wherein the first lateral edge in a turn of the fabric strip abuts the second lateral edge of an adjacent turn thereof. A helically continuous seam separating adjacent turns of the fabric strip is thereby formed. The helically continuous seam is closed by attaching abutting first and second lateral edges of the fabric strip to one another. In this manner, a base fabric is provided in the form of an endless loop having a machine direction, a cross-machine direction, an inner surface and an outer surface.

[0022] The base fabric may comprise one or more additional layers formed by spirally winding fabric strips, which may be woven from lengthwise yarns and crosswise yarns, or which alternatively may be nonwoven mesh fabrics of the above-identified variety. The additional fabric strips also have first lateral edges and second lateral edges, and are spirally wound in a plurality of contiguous turns wherein the first lateral edge in a turn of each additional fabric strip abuts the second lateral edge of an adjacent turn thereof. Helically continuous seams separating adjacent turns of the additional fabric strips are thereby formed. The helically continuous seams are closed by attaching abutting first and second lateral edges of each additional fabric strip to one another. In this manner, one or more additional layers are provided in the form of endless loops having a machine direction, a cross-machine direction, an inner surface and an outer surface. Preferably, at least some of the additional fabric strips are spirally wound in a direction opposite to that in which the first fabric strip is spirally wound. The endless loops formed by the additional layers are disposed within or without the endless loop formed by the first layer.

[0023] A plurality of layers of staple fiber material is attached to one or both of the inner and outer surfaces of the base fabric. At the same time, where the base fabric includes more than one layer, the layers are attached to one another by individual fibers of the staple fiber material needled therethrough. The fibers making up the layers of staple fiber material are predominantly oriented at oblique angles relative to the machine direction of the base fabric, and are considered to constitute an angular web. That is to say, more specifically, the fibers in each of the plurality of layers of staple fiber material are predominantly oriented substantially parallel to one another in a direction making an oblique angle with respect to the machine direction. Moreover, the oblique angle is the same for each of the plurality of layers. Finally, the direction for each of the plurality of layers has an orientation opposite to that of any immediately underlying or overlying layer, so as to produce a criss-crossed angular web.

[0024] The present invention will now be described in more complete detail with frequent reference being made to the figures identified below.

Brief Description of the Drawings

[0025]

Figure 1 is a schematic top plan view illustrating a method for manufacturing one of the layers of the base fabric of the multi-axial press fabric of the present invention;

Figure 2 is a top plan view of the finished layer of the base fabric;

Figure 3 is a cross-sectional view taken as indicated by line 3-3 in Figure 1;

Figure 4 is a top plan view of a two-layer, laminated base fabric for the multi-axial press fabric of the present invention;

Figure 5 is an enlarged schematic view of a portion of the outer surface of the two-layer laminated base fabric;

Figure 6 is a perspective view of the multi-axial press fabric of the present invention; and

Figure 7 is an enlarged schematic view of a portion of the outer surface of the multi-axial press fabric.

Detailed Description of the Preferred Embodiment

[0026] Referring now to the several figures, Figure 1 is a schematic top plan view illustrating a method for manufacturing one of the layers of the base fabric of the multi-axial press fabric of the present invention. The method may be practiced using an apparatus 10 comprising a first roll 12 and a second roll 14, which are parallel to one another and which may be rotated in the directions indicated by the arrows. A woven fabric strip 16 is wound from a stock roll 18 around the first roll 12 and the second roll 14 in a continuous spiral. It will be recognized that it may be necessary to translate the stock roll 18 at a suitable rate along second roll 14 (to the right in Figure 1) as the fabric strip 16 is being wound around the rolls 12,14.

[0027] The first roll 12 and the second roll 14 are separated by a distance D, which is determined with reference to the total length, C, required for the base fabric layer being manufactured, the total length, C, being measured longitudinally (in the machine direction) about the endless-loop form of the layer. Woven fabric strip 16, having a width w, is spirally wound onto the first and second rolls 12,14 in a plurality of turns from stock roll 18, which may be translated along the second rolls 14 in the course of the winding. Successive turns of the fabric strip 16 are abutted against one another and are attached to one another along helically continuous seam 20 by sewing, stitching, melting or welding to produce base fabric layer 22 as shown in Figure 2. When a sufficient number of turns of the fabric strip 16 have been made to produce layer 22 in the desired width W, that width being measured transversely (in the cross-machine direction) across the endless-loop form of the layer 22, the spiral winding is concluded. The base fabric layer 22 so obtained has an inner surface, an outer surface, a machine direction and a cross-machine direction. Initially, the lateral edges of the base fabric layer 22, it will be apparent, will not be parallel to the machine direction thereof, and must be trimmed along lines 24 to provide the layer 22 with the desired width W, and with two lateral edges parallel to the machine direction of its endless-loop form.

[0028] Fabric strip 16 may be woven from monofilament, plied monofilament or multifilament yarns of a synthetic polymeric resin, such as polyester or polyamide, in the same manner as other fabrics used in the papermaking industry are woven. After weaving, it may be heat-set in a conventional manner prior to interim storage on stock roll 18. Fabric strip 16 includes lengthwise yarns and crosswise yarns, wherein, for example, the lengthwise yarns may be plied monofilament yarns while the crosswise yarns may be monofilament yarns. Further, fabric strip 16 may be of a single- or multi- layer weave.

[0029] Alternatively, fabric strip 16 may be woven and heat-set in a conventional manner, and fed directly to apparatus 10 from a heat-set unit without interim storage on a stock roll 18. It may also be possible to eliminate heat-setting with the proper material selection and product construction (weave, yarn sizes and counts). In such a situation, fabric strip 16 would be fed to the apparatus 10 from a weaving loom without interim storage on a stock roll 18.

[0030] Fabric strip 16 may also be a nonwoven mesh fabric of the variety disclosed in commonly assigned U. S. Patent No. 4,427,734 to Johnson, the teachings of which are incorporated herein by reference. The mesh fabric is a net-like structure of ribs or yarns separated by mesh. The monofilament-like elements making up the mesh fabric are oriented in the lengthwise and crosswise directions thereof.

[0031] Figure 3 is a cross section of fabric strip 16 taken as indicated by line 3-3 in Figure 1. It comprises lengthwise yarns 26 and crosswise yarns 28, both of which are represented as monofilaments, interwoven in a single-layer weave. More specifically, a plain weave is shown, although, it should be understood, the fabric strip 16 may be woven according to any of the weave patterns commonly used to weave paper machine clothing. Because the fabric strip 16 is spirally wound to assemble base fabric layer 22, lengthwise yarns 26 and crosswise yarns 28 do not align with the machine and cross-machine directions, respectively, of the layer 22. Rather, the lengthwise yarns 26 make a slight angle, θ, whose magnitude is a measure of the pitch of the spiral windings of the fabric strip 16, with respect to the machine direction of the layer 22, as suggested by the top plan view thereof shown in Figure 2. This angle, as previously noted, is typically less than 10°. Because the crosswise yarns 28 of the fabric strip 16 generally cross the lengthwise yarns 26 at a 90° angle, the crosswise yarns 28 make the same slight angle, θ, with respect to the cross-machine direction of the layer 22.

[0032] Woven fabric strip 16 has a first lateral edge 30 and a second lateral edge 32 which together define the width of the body of the woven fabric strip 16. As the fabric strip 16 is being spirally wound onto the first and second rolls 12, 14, the first lateral edge 30 of each turn is abutted against the second lateral edge 32 of the immediately preceding turn and attached thereto.

[0033] If desired, a second base fabric layer for the multi-axial press fabric of the present invention may be provided on top of base fabric layer 22 before removing base fabric layer 22 from apparatus 10. The second base fabric layer 34 may be fashioned in the same manner as is described above. Preferably, second base fabric layer 34 is manufactured to spiral in a direction opposite to that of base fabric layer 22 by starting at the right side of second roll 14 in Figure 1, rather than at the left side, as was the case for the manufacture of base fabric layer 22, and by translating stock roll 18 at a suitable rate to the left along second roll 14 as the fabric strip 16 is being wound around the rolls 12,14. It will be appreciated that fabric strip 16 will have to be wound in a sufficient number of turns to completely cover base

fabric layer 22, and that the lateral edges of second base fabric layer 34 will have to be trimmed to be rendered parallel to the machine direction and to conform to those of base fabric layer 22. The result is shown in Figure 4, where helically continuous seam 20 of base fabric layer 22 is shown as a dashed line. Additional layers, spiralling in either direction, may be provided in the same manner.

[0034] Figure 5 is an enlarged schematic view of a portion of the outer surface of the two-layer, laminated base fabric 36. Second layer 34, whose lengthwise (warp) yarns 42 and crosswise (filling) yarns 44 are represented by solid lines, overlies first layer 22, whose lengthwise (warp) yarns 38 and crosswise (filling) yarns 40 are represented by dashed lines. Both lengthwise (warp) yarns 38 and lengthwise (warp) yarns 42 make relatively small angles with respect to the machine direction (MD) of base fabric 36, and, because first layer 22 and second layer 34 spiral in opposite directions, cross each other at a relatively small angle that is equal to the sum of the angles each makes with the machine direction. Similarly, both crosswise (filling) yarns 40 and crosswise (filling) yarns 44 make small angles with respect to the cross-machine direction (CD) of base fabric 36, and cross each other at a relatively small angle that is equal to the sum of the angles each makes with the cross-machine direction. As a consequence, the two-layer, laminated base fabric 36 has no defined machine- or cross-machine-direction yarns. Instead, lengthwise (warp) yarns 38 and crosswise (filling) yarns 40 of the first layer 22 and lengthwise (warp) yarns 42 and crosswise (filling) yarns 44 of the second layer 34 lie in four different directions at oblique angles to the machine and cross-machine directions. For this reason, base fabric 36 is considered to be multi-axial.

[0035] Figure 6 is a perspective review of a multi-axial press fabric 46 of the present invention. Press fabric 46 is in the form of an endless loop having an inner surface 48 and an outer surface 50, and comprises base fabric 36.

[0036] The outer surface 50 of multi-axial press fabric 46 has a plurality of layers of staple fiber material attached thereto by needling. The needling of the layers of staple fiber material into the outer surface 50 of the press fabric 46 also attaches the first and second layers 22, 34 of the base fabric 36 to one another, as the needling drives individual fibers of the staple fiber material into and through the overlying first and second layers 22, 34. The staple fiber material may be of polyamide, polyester or any of the other varieties of staple fiber used by those of ordinary skill in the art to manufacture paper machine clothing. In general, one or both of the inner and outer surfaces of the press fabric have a plurality of layers of staple fiber material attached thereto by needling.

[0037] Within each of the plurality of layers of staple fiber material, the fibers are predominantly oriented at oblique angles with respect to the machine direction of the multi-axial press fabric 46, except, of course, where they have been driven into and through the first and second layers 22,34 of the base fabric 36 in a direction essentially perpendicular thereto by the needling.

[0038] Figure 7 is an enlarged schematic view of a portion of the outer surface 50 of the press fabric 46. The individual fibers in the plurality of layers of staple fiber material are predominantly oriented in the directions suggested by the crisscrossed lines in the figure. These directions are at oblique angles relative to the machine direction, and so, therefore, except for the portions of individual fibers driven into the base fabric 36 by needling, the fibers are predominantly oriented at oblique angles relative to the machine direction of the multi-axial press fabric 46, and are substantially parallel to one another in those directions. The fibers in layers immediately overlying or underlying any given layer are predominantly oriented in the other of the two directions, as suggested by the crisscrossed pattern in Figure 7.

[0039] The plurality of layers of staple fiber material are assembled in accordance with the teachings of commonly assigned U.S. Patents Nos. 3,879,820 and 3,920,511 to Grieves et al., the teachings of which are incorporated herein by reference. These patents, which are related as having been issued from applications divided from a common parent application, show a non-woven papermaker's fabric lacking a base fabric. The papermaker's fabric is produced by crosslapping a staple fiber batt, whose fibers are initially parallel to one another in the longitudinal direction of the batt, onto a floor apron to produce a sheet having several layers of staple fiber batt. In each of the several layers of the sheet, the fibers are predominantly oriented at an angle from 45° to 85° relative to its longitudinal direction.

[0040] The sheet is then consolidated to give it some structural integrity, at which time the fibers in each layer become oriented at an angle of approximately 66° relative to the longitudinal direction of the sheet.

[0041] The sheet is then crosslapped again, this time to a width equal to that desired for the non-woven papermaker's fabric. The fabric, comprising several overlapped layers of the sheet, is then needled together. The fibers in each layer of the fabric, having been subjected to two successive crosslapping operations, lie in directions making an angle from 10° to 40° relative to the longitudinal direction.

[0042] It should be understood that the angular ranges quoted in the preceding paragraphs are determined by the parameters of the crosslapping machine actually used to manufacture the fabric. In any event, the fibers in each layer of the fabric are predominantly oriented in directions making an oblique angle relative to the longitudinal direction thereof.

[0043] The plurality of layers of staple fiber material needled into the base fabric 36 to produce the multi-axial press fabric 46 of the present invention are assembled in accordance with the teachings of these patents in a width equal to that of the base fabric 36, and are depos-

ited lengthwise around the outer surface of the base fabric 36 and needled thereunto, to produce the multi-axial base fabric 46 of the present invention.

[0044] As advantages, the present invention displays an improved caliper retention, superior long-term water handling and pressure distribution, an ease of cleaning, superior sheet finish and an improved cross-machine profile.

[0045] Modifications to the multi-axial press fabric of the present invention would be obvious to those of ordinary skill in the art, but would not bring the invention so modified beyond the scope of the appended claims. For example, the base fabric thereof may comprise, in addition to one or more spirally wound layers, one or more layers of standard base fabric. That is to say, one or more additional layers may be formed by fabrics having machine- and cross-machine direction yarns and produced by techniques well-known to those of ordinary skill in the art. Such a fabric may be woven endless in the dimensions required for the paper machine for which it is intended, or flat woven and subsequently rendered into endless form with a woven seam. It may also be produced by a modified endless weaving technique to be on-machine-seamable. Laminated fabrics, having one or more standard base fabric layers, may also be used.

[0046] Further, the multi-axial press fabrics of the present invention may also include one or more layers of standard staple fiber material, whose individual fibers have a more random orientation compared to those of an angular web; randomized staple fiber material; or lengthwise-oriented staple fiber material.

Claims

1. A multi-axial press fabric for the press section of a paper machine, said multi-axial press fabric comprising:

a base fabric, said base fabric having a first layer, said first layer comprising a first fabric strip, said first fabric strip having a first lateral edge and a second lateral edge, said first fabric strip being spirally wound in a plurality of contiguous turns wherein said first lateral edge in a turn of said first fabric strip abuts said second lateral edge of an adjacent turn thereof, thereby forming a helically continuous seam separating adjacent turns of said first fabric strip, said helically continuous seam being closed by attaching abutting first and second lateral edges of said first fabric strip to one another, thereby providing said first layer and said base fabric in the form of an endless loop having a machine direction, a cross-machine direction, an inner surface and an outer surface; and

a plurality of layers of staple fiber material attached to one of said inner and outer surfaces of said base fabric, said fibers in each of said plurality of layers of staple fiber material being predominantly oriented substantially parallel to one another in a direction making an oblique angle with respect to said machine direction, said oblique angle in each of said plurality of layers being substantially the same, and said direction in each of said plurality of layers having an orientation opposite to that of any immediately underlying or overlying layer, so as to produce a crisscrossed angular web.

2. A multi-axial press fabric as claimed in claim 1 wherein said first fabric strip is woven from lengthwise and crosswise yarns.

3. A multi-axial press fabric as claimed in claim 1 wherein said first fabric strip is a non-woven mesh fabric having lengthwise and crosswise elements.

4. A multi-axial press fabric as claimed in claim 1 wherein said base fabric further comprises a second layer, said second layer comprising a second fabric strip, said second fabric strip having a first lateral edge -and a second lateral edge, said second fabric strip being spirally wound in a plurality of contiguous turns wherein said first lateral edge in a turn of said second fabric strip abuts said second lateral edge of an adjacent turn thereof, thereby forming a helically continuous seam separating adjacent turns of said second fabric strip, said helically continuous seam being closed by attaching abutting first and second lateral edges of said second fabric strip to one another, thereby providing said second layer in the form of an endless loop having a machine direction, a cross-machine direction, an inner surface and outer surface, said endless loop formed by said second layer being nested within said endless loop formed by said first layer.

5. A multi-axial press fabric as claimed in claim 4 wherein said second fabric strip is spirally wound in a direction opposite to that in which said first fabric strip is spirally wound.

6. A multi-axial press fabric as claimed in claim 4 wherein said second fabric strip is woven from lengthwise and crosswise yarns.

7. A multi-axial press fabric as claimed in claim 4 wherein said second fabric strip is a nonwoven mesh fabric having lengthwise and crosswise elements.

8. A multi-axial press fabric as claimed in claim 4 wherein said base fabric further comprises at least one additional layer, said additional layer compris-

ing an additional fabric strip, said additional fabric strip having a first lateral edge and a second lateral edge, said additional fabric strip being spirally wound in a plurality of contiguous turns wherein said first lateral edge in a turn of said additional fabric strip abuts said second lateral edge of an adjacent turn thereof, thereby forming a helically continuous seam separating adjacent turns of said additional fabric strip, said helically continuous seam being closed by attaching abutting first and second lateral edges of additional fabric strip to one another, thereby providing said additional layer in the form of an endless loop having a machine direction, a cross-machine direction, an inner surface and outer surface, said endless loop formed by said additional layer being nested within said endless loops formed by said first and second layers.

9. A multi-axial press fabric as claimed in claim 8 wherein said additional fabric strip is woven from lengthwise and crosswise yarns.

10. A multi-axial press fabric as claimed in claim 8 wherein said additional fabric strip is a nonwoven mesh fabric having lengthwise and crosswise elements.

11. A multi-axial press fabric as claimed in claim 1 wherein said base fabric further comprises a standard base fabric having machine-direction and cross-machine-direction yarns, said standard base fabric being in the form of an endless loop having a machine direction, a cross-machine direction, an inner surface and an outer surface.

12. A multi-axial press fabric as claimed in claim 11 wherein said endless loop formed by said standard base fabric is nested within said endless loop formed by said first layer.

13. A multi-axial press fabric as claimed in claim 11 wherein said standard base fabric is endless.

14. A multi-axial press fabric as claimed in claim 11 wherein said standard base fabric is on-machine-seamable.

15. A multi-axial press fabric as claimed in claim 2 wherein said first fabric strip is of a single-layer weave.

16. A multi-axial press fabric as claimed in claim 2 wherein said first fabric strip is of a multi-layer weave.

17. A multi-axial press fabric as claimed in claim 2 wherein said lengthwise yarns and said crosswise yarns of said first fabric strip are of a synthetic polymeric resin.

18. A multi-axial press fabric as claimed in claim 1 wherein said first layer of said base fabric has lateral edges trimmed in a direction parallel to said machine direction thereof.

19. A multi-axial press fabric as claimed in claim 1 wherein said first fabric strip makes an angle of less than 10° with respect to said machine direction of said first layer.

20. A multi-axial press fabric as claimed in claim 6 wherein said second fabric strip is of a single-layer weave.

21. A multi-axial press fabric as claimed in claim 6 wherein said second fabric strip is of a multi-layer weave.

22. A multi-axial press fabric as claimed in claim 6 wherein said lengthwise yarns and said crosswise yarns of said second fabric strip are of a synthetic polymeric resin.

23. A multi-axial press fabric as claimed in claim 4 wherein said second layer of said base fabric has lateral edges trimmed in a direction parallel to said machine direction thereof.

24. A multi-axial press fabric as claimed in claim 1 wherein said second fabric strip makes an angle of less than 10° with respect to said machine direction of said second layer.

25. A multi-axial press fabric as claimed in claim 9 wherein said additional fabric strip is of a single-layer weave.

26. A multi-axial press fabric as claimed in claim 9 wherein said additional fabric strip is of a multi-layer weave.

27. A multi-axial press fabric as claimed in claim 9 wherein said lengthwise yarns and said crosswise yarns of said additional fabric strip are of a synthetic polymeric resin.

28. A multi-axial press fabric as claimed in claim 8 wherein said additional layer of said base fabric has lateral edges trimmed in a direction parallel to said machine direction thereof.

29. A multi-axial press fabric as claimed in claim 8 wherein said additional fabric strip makes an angle of less than 10° with respect to said machine direction of said layer.

30. A multi-axial press fabric as claimed in claim 11 wherein said standard base fabric is of a single-layer weave.

31. A multi-axial press fabric as claimed in claim 11 wherein said standard base fabric is of a multi-layer weave.

32. A multi-axial press fabric as claimed in claim 11 wherein said standard base fabric is laminated.

33. A multi-axial press fabric as claimed in claim 11 wherein said lengthwise yarns and said crosswise yarns of said standard base fabric are of a synthetic resin.

34. A multi-axial press fabric as claimed in claim 1 further comprising a plurality of layers of staple fiber material attached to the other of said inner and outer surfaces of said base fabric, said fibers in each of said plurality of layers of staple fiber material being predominantly oriented substantially parallel to one another in a direction making an oblique angle with respect to said machine direction, said oblique angle in each of said plurality of layers being substantially the same, and said direction in each of said plurality of layers having an orientation opposite to that of any immediately underlying or overlying layer, so as to produce a crisscrossed angular web.

35. A multi-axial press fabric as claimed in claim 1 further comprising a plurality of layers of staple fiber material attached to one of said inner and outer surfaces of said base fabric by needling, said staple fiber material being selected from the group consisting of standard staple fiber material, randomized staple fiber material, and lengthwise-oriented staple fiber material.

36. A multi-axial press fabric as claimed in claim 35 further comprising a plurality of layers of staple fiber material attached to the other of said inner and outer surfaces of said base fabric by needling, said staple fiber material being selected from the group consisting of standard staple fiber material, randomized staple fiber material, and lengthwise-oriented staple fiber material.

37. A multi-axial press fabric as claimed in claim 1 or claim 34 wherein said staple fiber material is of a polymeric resin material.

38. A multi-axial press fabric as claimed in claim 37 wherein said polymeric resin material is selected from the group consisting of polyamide and polyester resins.

39. A multi-axial press fabric as claimed in claim 35 or claim 36 wherein said staple fiber material is of a polymeric resin material.

40. A multi-axial press fabric as claimed in claim 39 wherein said polymeric resin material is selected from the group consisting of polyamide and polyester resins.

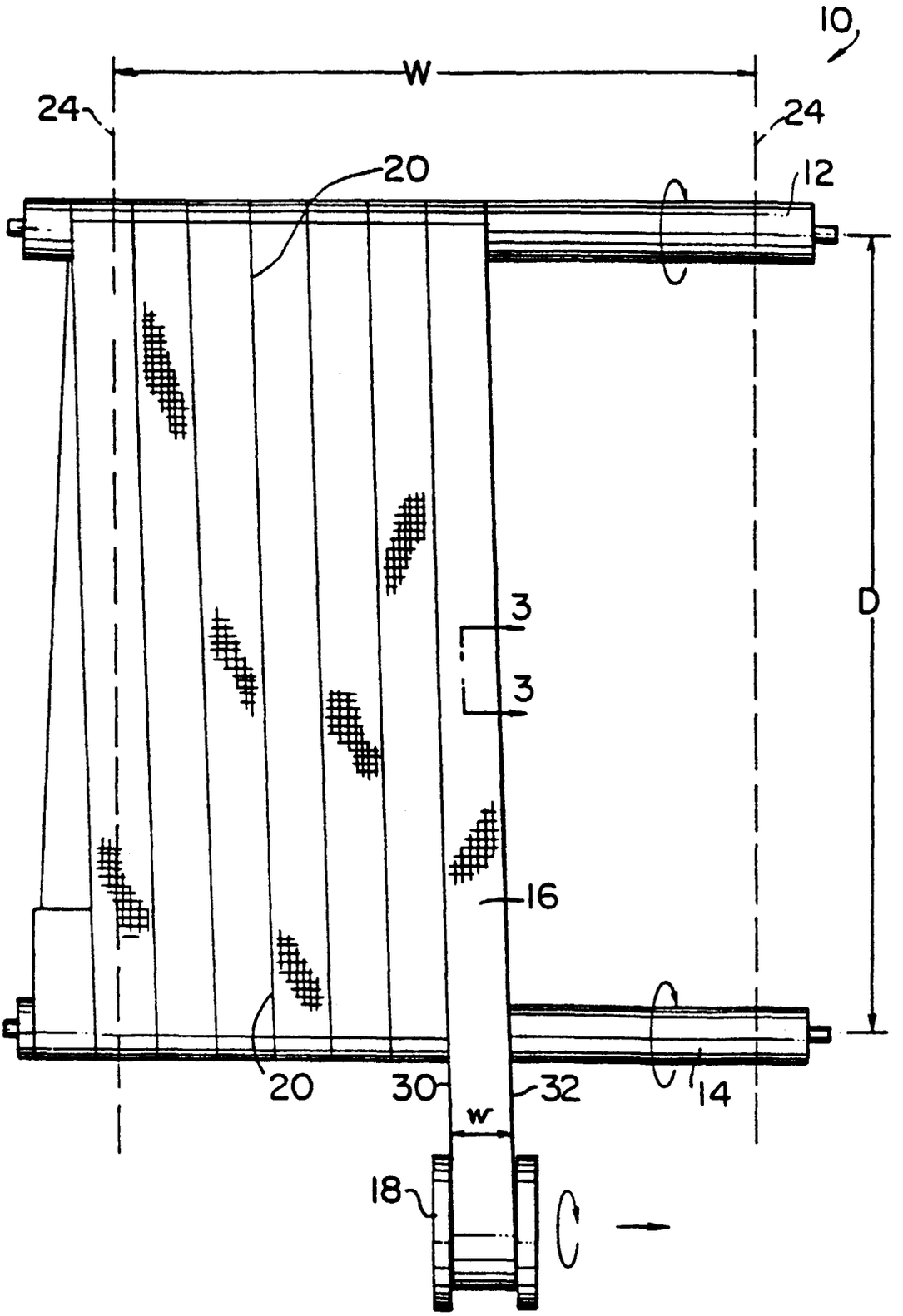

FIG.1

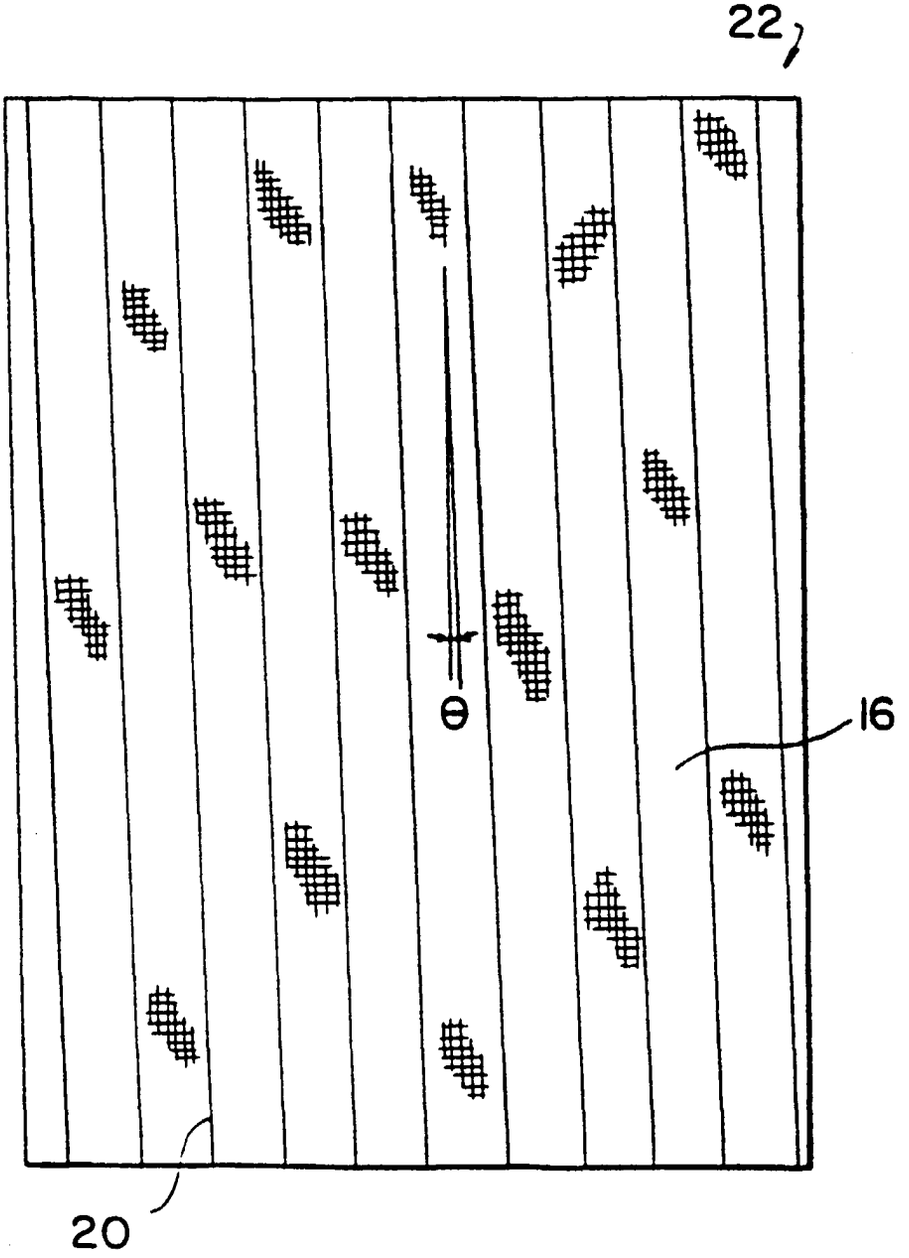

FIG.2

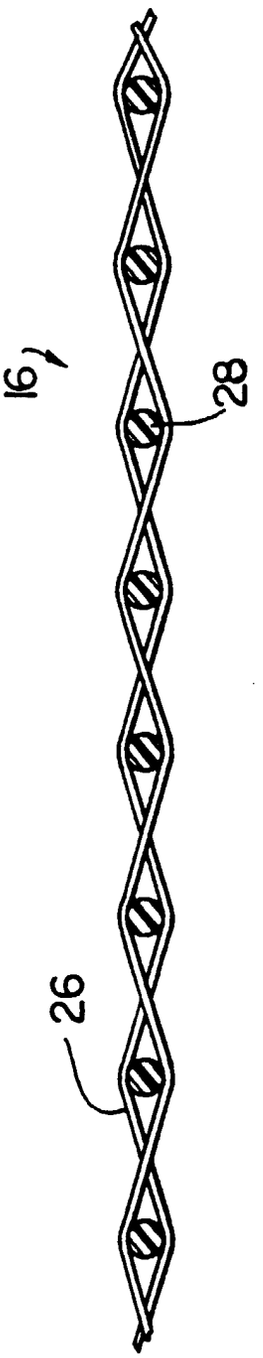

FIG.3

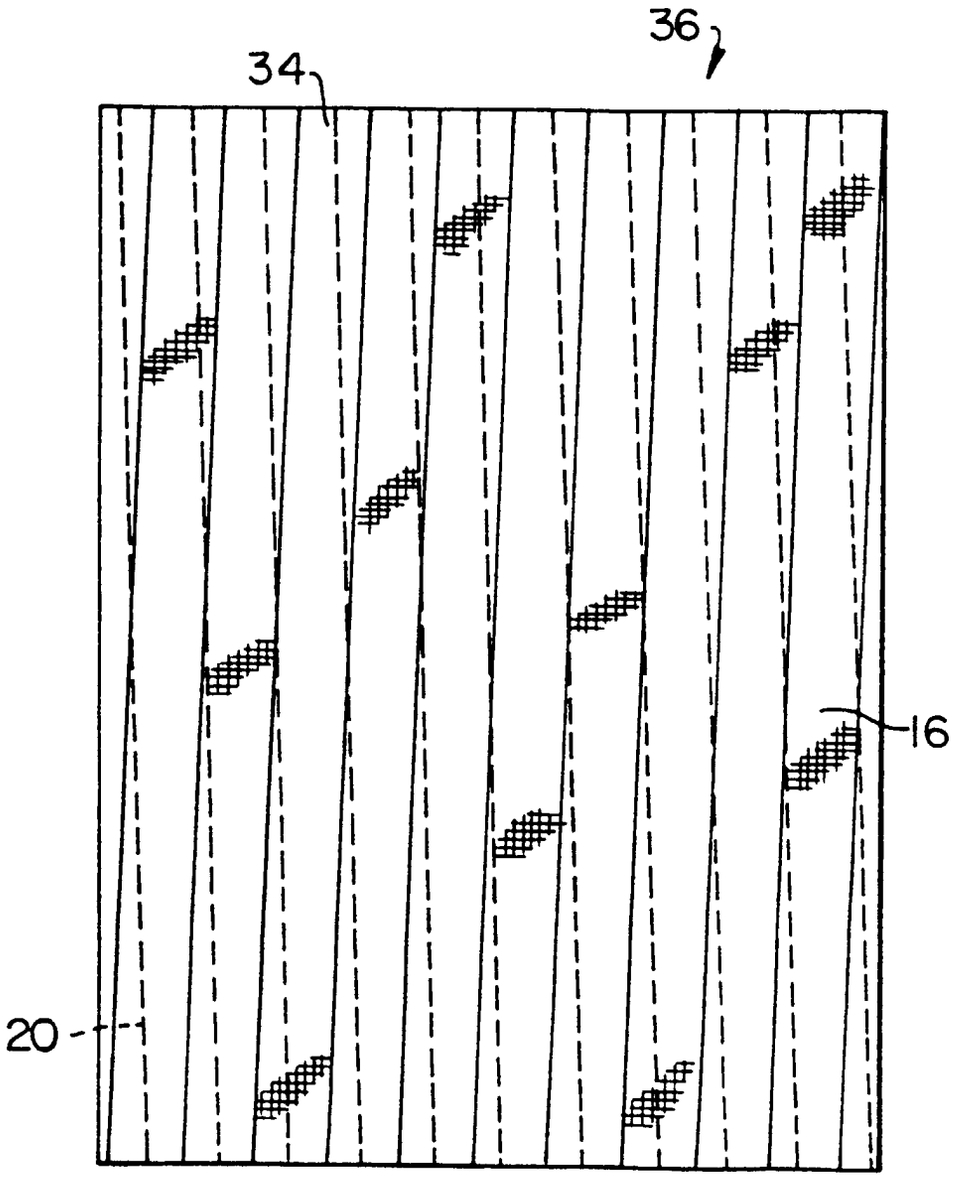

FIG. 4

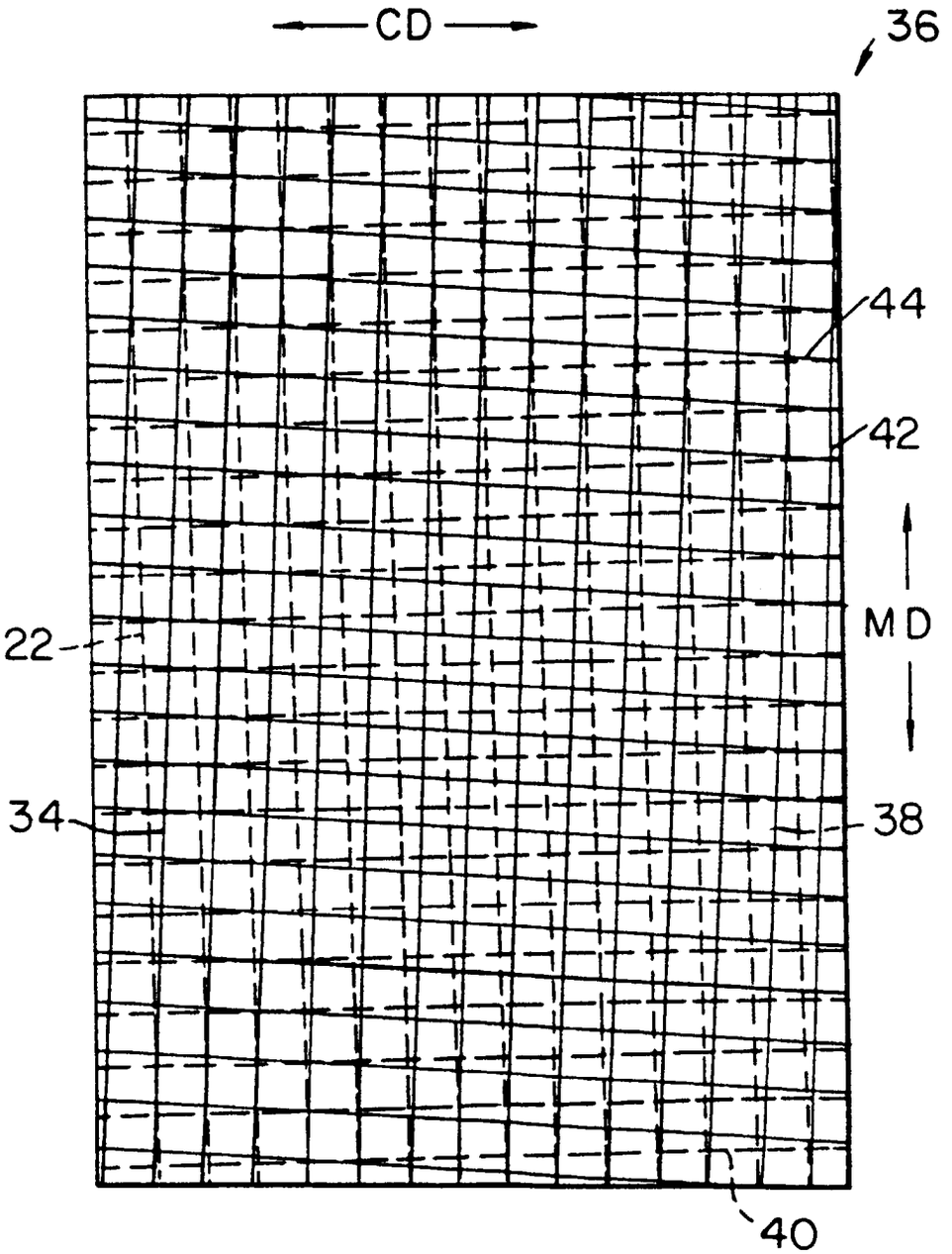

FIG. 5

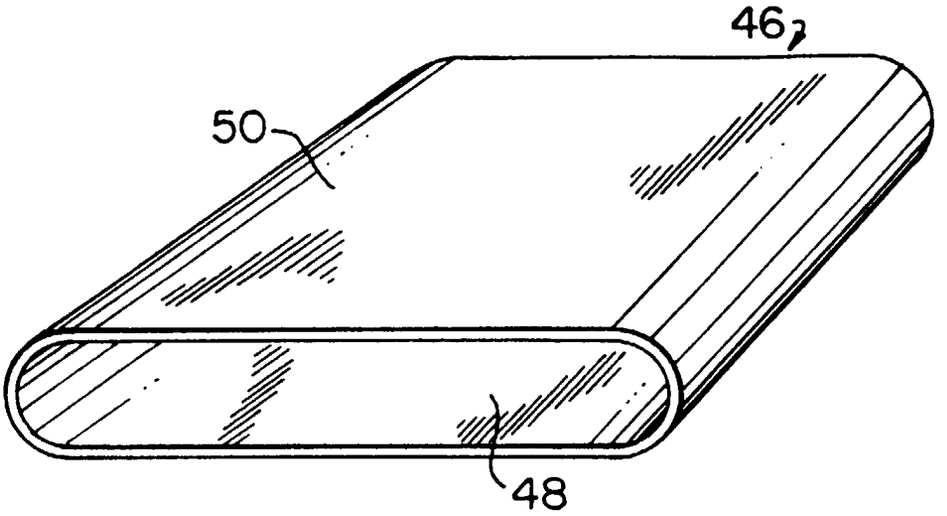

FIG. 6

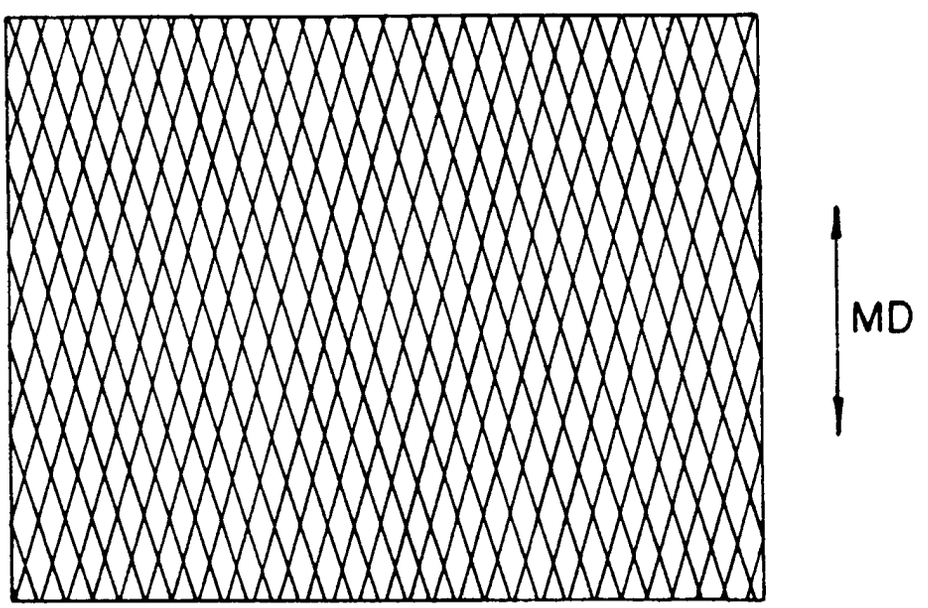

FIG. 7