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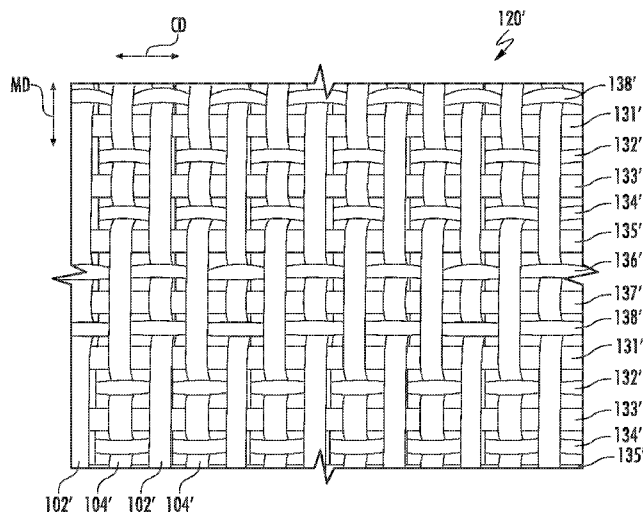


FIG. 5

(57) Abstract: An industrial textile is provided, preferably suitable for use as a dryer fabric in a papermaking machine. The industrial textile has first and second surfaces and is defined by first and second systems of warp yarns interwoven with a system of weft yarns in a repeating pattern. In the repeating pattern, each of the warp yarns in the first system of warp yarns is interwoven with the system of weft yarns with a float on the first surface over at least 5 of the weft yarns, under 1 of the weft yarns, over 1 of the weft yarns, and under 1 of the weft yarns. Additionally, each of the warp yarns in the second system of warp yarns is interwoven with the system of weft yarns with a float on the second surface under at least 5 of the weft yarns, over 1 of the weft yarns, under 1 of the weft yarns, and over 1 of the weft yarns in the repeating pattern. Each of the warp yarns of the first system of warp yarns is stacked over a corresponding one of the warp yarns of the second system of warp yarns to form stacked pairs of the warp yarns.



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HIGH STABILITY STACKED WARP YARN DRYER FABRIC  
WITH LONG WARP FLOATS

INCORPORATION BY REFERENCE

[0001] The following documents are incorporated herein by reference as if fully set forth: U.S. Provisional Patent Application No. 62/512,327, filed May 30, 2017.

BACKGROUND

[0002] The invention relates to industrial textiles, and more particularly to papermaking fabrics.

[0003] Numerous weaves are known in the art which are employed to achieve different results for different applications.

[0004] WO 2011/022831, which is assigned to the assignee of the present invention, discloses a dryer fabric for a papermaking machine having stacked warp yarns with about 193% warp fill woven with filler wefts and critical picks.

[0005] US 9,365,958 is directed to a stretchable fabric for clothing that is a single layer woven with long floats and is unrelated to papermaking fabrics or industrial conveying fabrics used in papermaking or filtration operations. There is therefore no need or concern with increasing the life of an industrial fabric, and in particular, a papermaking fabric by providing a machine side surface dominated by long machine direction (MD) floats for increased wear resistance.

SUMMARY

[0006] The invention concerns an industrial textile, preferably suitable for use as a dryer fabric in a papermaking machine. The industrial textile has first and second surfaces and is defined by first and second systems of warp yarns interwoven with a system of weft yarns in a repeating pattern. In the repeating pattern, each of the warp yarns in the first system of warp yarns is interwoven with the system of weft yarns on the first surface over at least 5 of the weft yarns, under 1 of the weft yarns, over 1 of the weft yarns, and under

1 of the weft yarns forming a float on the first surface over the at least 5 of the weft yarns. Additionally, each of the warp yarns in the second system of warp yarns is interwoven with the system of weft yarns on the second surface under at least 5 of the weft yarns, over 1 of the weft yarns, under 1 of the weft yarns, and over 1 of the weft yarns in the repeating pattern forming a float on the second surface under the at least 5 of the weft yarns. Each of the warp yarns of the first system of warp yarns is stacked over a corresponding one of the warp yarns of the second system of warp yarns to form stacked pairs of the warp yarns.

[0007] In one embodiment, the float on the first surface is over 7 weft yarns, and the float on the second surface is under 7 weft yarns.

[0008] Preferably, the system of weft yarns includes alternating larger diameter filler wefts and smaller diameter critical picks.

[0009] In one preferred arrangement, the warp yarns of the first system of warp yarns only weave under the critical picks, and the warp yarns of the second system of warp yarns only weave over the critical picks.

[0010] Preferably, the repeating pattern of the warp yarns of the first system of warp yarns of under 1 of the weft yarns, over 1 of the weft yarns and under 1 of the weft yarns forms a locking weave for maintaining a position of the warp yarns of the first system of warp yarns, and the repeating pattern of the warp yarns of the second system of warp yarns of over 1 of the weft yarns, under 1 of the weft yarns, and over 1 of the weft yarns forms a locking weave for maintaining a position of the warp yarns of the second system of warp yarns. In preferred arrangements for certain filter fabrics, this allows the stacked pairs of the warp yarns to be spaced apart to form an open mesh pattern while still maintaining a high stability for the industrial textile. On one preferred arrangement, the stacked pairs of the warp yarns are spaced apart by at least 40% of a cross-direction dimension of one of the warp yarns.

[0011] In one preferred arrangement, the floats on the first surface are arranged with a diagonal twill.

[0012] In one embodiment, the first system of warp yarns is made from a different material than the second system of warp yarns.

[0013] In several of the preferred arrangements, the warp yarns of the first and second systems of warp yarns have a rectangular cross-section. Preferably, the cross-section of the warp yarns of the first and second systems of warp yarns are the same. Preferably, the weft yarns have a circular cross-section. However, this can be varied. The warp and/or weft yarns may be grooved and/or profiled in the manner described by US 6,773,786 to assist in rendering the fabric contamination resistant.

[0014] For a preferred application, the first system of warp yarns and second system of warp yarns each have at least about 96% warp fill. This is particularly useful for dryer fabrics for papermaking machines.

[0015] In one arrangement where the floats in the first and second systems of warp yarns are over 5 of the weft yarns on a top surface and under 5 weft yarns on a bottom surface, the industrial textile is woven with an 8 shed, 10 step pattern. Depending on the length of the warp floats, the number of steps needed to weave the industrial textile may need to be increased.

[0016] As noted above, the present industrial textile has preferred applications as a papermaking fabric. The industrial textile is preferably flat woven, and the ends are seamed to form an endless belt that can then be used in papermaking applications on a papermaking machine. One preferred application is a dryer fabric for a papermaking fabric.

[0017] The resulting constructions are a rugged and wear resistant industrial textile that resists warp nesting and canting and is highly stable (meaning it is resistive to out of plane distortion due in part to its diagonal stability). The fabric is adaptable to a wide range of applications by appropriate selection of warp and weft yarn types, sizes and shapes. For example, air permeability of the fabric is easily adjusted according to need; the fabric can be rendered temperature or contamination resistant by appropriate selection of the warp yarn materials and sizes. In addition the fabric provides for high seam strength due to the stacked warp construction which preferably utilizes approximately 100% of the warp yarns to form the seam, and which also provides the fabric with approximately 200% warp fill. The term "warp fill" refers to the amount of warp yarns in a given space relative to total space

considered. Warp fill can be over 100% when there are more warp strands jammed into the available space than the space can dimensionally accommodate in a single plane. A fabric with approximately 200% warp fill or more may have two layers of warp yarns each woven at at least approximately 100% warp fill. In this context, those skilled in the art would understand that 190% to 210% would be considered approximately 200% warp fill. The fabric can be highly stable, and resists creasing and distortion when the warp yarns in each layer are woven at 100% warp fill, or more, and are thus immediately adjacent to and braced against one another. This in combination with the locking weave of the warp yarns provides enhanced stability in combination with increased longevity due to the long warp floats. The weave pattern of the novel fabrics provide long floats of the warp yarns on both exterior surfaces that enhance the ability of these fabrics to resist abrasive wear.

[0018] The fabric design can be adapted for many different applications by proper warp and weft selection which will allow the fabric to obtain a wide range of air permeabilities. Although fabric caliper (thickness) can be made low to allow for use in high speed applications, the stability of the textile is maintained due to the warp yarn bracing and locking weave provided with the weft yarns. The two independent warp systems provide a further benefit in that the materials used in each can be optimized to resist the environmental effects to which each fabric surface is exposed. For example, the monofilament warp yarns used to form a first fabric surface can be comprised of PPS (polyphenylene sulfide) or PCTA (polycyclohexane dimethanol terephthalic acid) polymers which are more resistant to thermal and hydrolytic degradation than PET (polyethylene terephthalate) yarns (and more expensive). Warp yarns formed from PET polymer could be utilized on the paper side of the textile (in papermaking applications) where heat and hydrolysis resistance are less critical properties.

[0019] Fabrics according to the invention such as are shown in the Figures were woven using rectangular cross-section polymeric monofilament warp yarns whose dimensions are 0.25 x 1.05mm or 0.36 x 1.07mm to obtain a width to height ratio of between 4:1 and 3:1, but other cross-sectional shapes

and ratios may be employed. The weft yarns used in these fabrics have a generally circular cross-sectional shape and range in size from about 0.50mm to 1.0mm; although other sizes may be employed depending upon the specific application.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The foregoing Summary and the following detailed description will be better understood when read in conjunction with the appended drawings, which illustrate a preferred embodiment of the invention. In the drawings:

[0021] Figure 1 is a weave diagram showing a first embodiment of an industrial textile having the present construction.

[0022] Figure 2 is a cross-sectional view showing the weave pattern of two of the stacked warp yarns in the fabric construction shown in Figure 1.

[0023] Figure 3 is a top view of a second embodiment of an industrial textile of the present construction.

[0024] Figure 4 is a cross-sectional view showing the weave paths of two pairs of stacked warp yarns shown in Figure 3.

[0025] Figure 5 is a top view of an industrial textile according to a third embodiment of the present construction.

[0026] Figure 6 is a cross-sectional view showing the weave path of two pairs of the stacked warp yarns shown in Figure 5.

[0027] Figure 7 is a weave diagram showing a fourth embodiment of an industrial textile having the present construction.

[0028] Figure 8 is a cross-sectional view showing the weave pattern of two of the stacked warp yarns in the fabric construction shown in Figure 7.

[0029] Figure 9 is a weave diagram of a fifth embodiment of an industrial textile having a high stability construction.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0030] Certain terminology is used in the following description for convenience only and is not limiting. The fabric according to the invention is an industrial textile, which can have many industrial applications, such as

conveyor belts, filtration fabrics, specialty fabrics for non-woven applications, etc. The words "paper side" (PS) and "machine side" (MS) designate surfaces of the fabric with reference to their use in one preferred application in a papermaking machine; however, these terms merely represent first and second or upper and lower surfaces of the planar fabric. "Yarn" is used to generically identify a monofilament or multifilament fiber. "Warp" and "weft" are used to designate yarns or monofilaments based on their position in the loom that extend in perpendicular directions in the fabric and either could be a machine direction (MD) or cross-machine direction (CMD) yarn in the fabric once it is installed on a papermaking machine, depending on whether the fabric is flat woven or continuously woven. In the preferred arrangement, the fabric is flat woven and seamed at the warp ends in order to form a continuous belt, so that the warp yarns are MD yarns and the weft yarns are CMD yarns.

[0031] One preferred application of the fabrics according to the invention is on a papermaking machine, and the fabric could have application as a base for a press fabric, or a dryer fabric for use in the corresponding press and dryer sections of a papermaking machine. These are generally all referred to as a "papermaking fabric" regardless of the position of use in a papermaking machine. Other applications include filtration fabrics, as well as other non-woven applications.

[0032] Referring to Figures 1 and 2, an industrial textile 20 in accordance with a first preferred embodiment of the present construction is illustrated using a weave diagram (Fig. 1) and a cross-section taken along the MD. The industrial textile 20 includes a first surface 24 and a second surface 26. In one preferred construction as a papermaking fabric, the first surface 24 corresponds to the PS and the second surface 26 corresponds to the MS.

[0033] The industrial textile 20 is woven with first and second systems of warp yarns 21, 22, which are interwoven with a system of weft yarns 30 in a repeating pattern. The warp yarns are identified as warp yarns 1-16, with the first group of warp yarns including the even numbered warp yarns, i.e., 2, 4, 6, 8, 10, 12, 14, 16, and the second system of warp yarns including the odd numbered warp yarns, i.e. 1, 3, 5, 7, 9, 11, 13, 15. The weft yarns 31-40 are

interwoven with the warp yarns 1-16, of which preferably there are alternating larger diameter filler wefts 31, 33, 35, 37, 39, and a smaller diameter critical picks 32, 34, 36, 38, 40. Each of the warp yarns 2, 4, 6, 8, 10, 12, 14, 16 in the first system of warp yarns 21 is interwoven with the system of weft yarns 30 with a float on the first surface 24 over at least five of the weft yarns 31 - 40. In the first embodiment of the industrial textile 20, the floats of each of the warp yarns 2, 4, 6, 8, 10, 12, 14, 16 in the first system of warp yarns 21 are over 7 of the weft yarns 31-40. This is shown in connection with the warp yarn 2 in Figure 2 and would be true for each of the warp yarns 2, 4, 6, 8, 10, 12, 14, 16 in the first system of warp yarns 21. In order to form a locking weave each of the warp yarns 2, 4, 6, 8, 10, 12, 14, 16 of the first system of warp yarns 21 then extends under one of the weft yarns 32, 34, 36, 38, 40, over one of the weft yarns 31, 33, 35, 37, 39, and under another one of the weft yarns 32, 34, 36, 38, 40 in the repeating pattern. Preferably the warp yarns 2, 4, 6, 8, 10, 12, 14, 16 of the first system of warp yarns 21 only weave under the critical picks 32, 34, 36, 38, 40. Preferably, the first and second systems of warp yarns 21, 22 are woven with 8 sheds in 10 steps.

[0034] Each of the warp yarns 1, 3, 5, 7, 9, 11, 13, 15 in the second system of warp yarns 22 is interwoven with the system of weft yarns 30 with a float on the second surface 26 under at least five of the weft yarns 31-40. In the first embodiment 20, preferably the warp yarns 1, 3, 5, 7, 9, 11, 13, 15 in the second system of warp yarns 22 are interwoven with the system of weft yarns 30 with a float on the second surface under 7 of the weft yarns 31-40. In order to form the locking weave, the warp yarns 1, 3, 5, 7, 9, 11, 13, 15 in the second system of warp yarns 22 then weave over one of the weft yarns 32, 34, 36, 38, 40 under one of the weft yarns 31, 33, 35, 37, 39, and over one of the weft yarns, 32, 34, 36, 38, 40 in the repeating pattern. As shown, each of the warp yarns 2, 4, 6, 8, 10, 12, 14, 16 of the first system of warp yarns 21 is stacked over a corresponding one of the warp yarns 1, 3, 5, 7, 9, 11, 13, 15 of the second system of warp yarns 22 to form stacked pairs of warp yarns. As illustrated in Figure 2, warp yarn 2 is stacked over warp yarn 1. With respect to the weave diagram shown in Figure 1, the even numbered warp yarns 2, 4,

6, 8, 10, 12, 14, 16 in the first system of warp yarns 21 are stacked over the corresponding ones of the odd numbered warp yarns 1, 3, 5, 7, 9, 11, 13, 15 in the second system of warp yarns 22. The warp yarns 1, 3, 5, 7, 9, 11, 13, 15 of the second system of warp yarns 22 only weave under the critical picks 32, 34, 36, 38, 40 which have the smaller diameter D2 than the filler wefts 31, 33, 35, 37 which have a larger diameter D1. The repeating pattern of the warp yarns 2, 4, 6, 8, 10, 12, 14, 16 of the first system of warp yarns 21 of under one of the weft yarns, over one of the weft yarns and under one of the weft yarns forms a locking weave for maintaining a position of the warp yarns 2, 4, 6, 8, 10, 12, 14, 16 of the first system of warp yarns 21 in position within the industrial textile. The repeating pattern of the warp yarns 1, 3, 5, 7, 9, 11, 13, 15 of the second system of warp yarns 22 of over one of the weft yarns, under one of the weft yarns, and over one of the weft yarns, also forms a locking weave for maintaining a position of the warp yarns 1, 3, 5, 7, 9, 11, 13, 15 of the second system of warp yarns 22 in position.

[0035] In a preferred arrangement of the industrial textile 20, 100% warp fill is provided for each of the first and second systems of warp yarns 21, 22, which, in combination with the locking weaves, provide an extremely stable fabric 20.

[0036] In a preferred arrangement, the warp yarns 1-16 preferably have a rectangular cross-sectional shape which contributes to the stability of the fabric 20 and its smoothness. The warp yarns 1-16 are preferably monofilaments formed of a polymeric material. In one embodiment, the dimensions are 0.25 x 1.05 mm or 0.36 x 1.07 mm to obtain a width to height ratio of between 4:1 and 3:1. Those skilled in the art will recognize that other cross-sectional shapes and ratios may also be used, such as oval or flattened shapes with rounded sides and aspect ratios of 2:1 to 6:1. The weft yarns 31-40 preferably have a circular cross-sectional shape that in some preferred arrangements may range in size from 0.6 mm, 0.7 mm, 0.8 mm, or 0.9 mm. Other sizes may also be used depending on the intended application for the fabric. In one preferred arrangement, the fabric 20 is woven at 22 picks per inch (weft yarns per inch) ( 8.7 yarns/cm).

[0037] The use of first and second systems of warp yarns, 21, 22 also allow different materials to be used for the first and second system of warp yarns 21, 22 in order to provide optimal materials on the first and second surfaces 24, 26, of the industrial textile 20 for the preferred application.

[0038] For example, the monofilament warp yarns 2, 4, 6, 8, 10, 12, 14, 16 of the first system of warp yarns 21 used to form the first surface 24 can be comprised of PPS (polyphenylene sulfide) or PCTA (polycyclohexane dimethanol terephthalic acid) polymers which are more resistant to thermal and hydrolytic degradation than PET (polyethylene terephthalate) yarns (and more expensive). The warp yarns 1, 3, 5, 7, 9, 11, 13, 15 of the second system of warp yarns can be formed from PET polymer since the PS of the textile (at least in papermaking applications) is where heat and hydrolysis resistance are less critical yarn properties. Those skilled in the art will understand from the present disclosure that these materials are merely exemplary, and that other materials could be used depending on the particular application. These warp yarns 1- 16 may be grooved, profiled, coated, or otherwise treated for contamination resistance.

[0039] Additionally, due to the long warp floats, a higher contact area can be achieved that reduces fabric wear rates in comparison to similar fabrics having more defined knuckles due to the weave. The long warp floats also provide for benefits in contamination resistance in comparison to similar weft proud fabrics.

[0040] Preferably, industrial textile 20 is formed into a continuous loop for use as a papermaking fabric, and more particularly as a papermaking dryer fabric, for use on a papermaking machine. In order to form the loop, a seam is created at the ends of the warp yarns 1-16. Preferably, the seam uses 100% of the warp yarns to form the seam. Seams can be formed in a known manner by unweaving and back-weaving warp yarns from the first system of warp yarns 21 back into the fabric along the paths of the corresponding stacked ones of the warp yarns from the second system of warp yarns 22 that have been cut back from the end of the fabric to form seam loops at each end of the planar fabric, with the seam loops then being interdigitated and joined by

a pintle to form an endless fabric loop. Other types of seaming, such as QuickLink seam, which was developed by AstenJohnson, the assignee of the present invention, can also be utilized. In a preferred arrangement for papermaking, the warp fill is preferably about 200% warp fill, with each layer having warp yarns woven at about 100% warp fill. This contributes to the stability of the industrial textile 20 and helps to resist creasing and distortion due to the fact that the warp yarns 1-16 in each layer are woven at about 100% warp fill, and thus are immediately adjacent to and braced against one another. This in connection with the locking weave provides enhanced fabric stability for the industrial textile 20.

[0041] Referring to Figures 3 and 4, a second embodiment of an industrial textile 120 is shown. The industrial textile 120 is similar to the industrial textile 20 and includes first and second systems of warp yarns 121, 122 that are interwoven with a system of weft yarns 130. The arrangement is similar to the industrial textile 20 with the exception that the floats in the first warp system 121 are over five of the weft yarns 131-138 and the floats in the second system of warp yarns 122 are under 5 of the weft yarns 131-138. The warp yarns 102, 104 of the first system of warp yarns 121 are woven in stacked pairs over the warp yarns 101, 103 of the second system of warp yarns 122 as shown. The warp yarn 102 weaves over weft yarns 131-135, under weft yarn 136 over weft yarn 137 and under weft 138. As in the first embodiment, the weft yarns 132, 134, 136, 138 are critical pics having a smaller diameter than the filler wefts 131, 133, 135, 137. The warp yarn 101 of the second system of warp yarns 122, which is stacked under the warp yarn 102, weaves under weft yarn 131, over weft yarn 132, under weft yarn 133, over weft yarn 134, and then under weft yarns 135-138. The next stacked pair of warp yarns 104, 103 are woven with the warp yarn 104 extending over weft yarn 131, under weft yarn 132, over weft yarn 133, under weft yarn 134, and over weft yarns 135-138. The warp yarn 103 which is stacked under the warp yarn 104 weaves under weft yarns 131-135 over weft yarn 136, under weft yarn 137, and over weft yarn 138. This stacked arrangement of warp yarns 101-104 extends across the fabric width in an alternating arrangement as shown in

Figure 3. As in the industrial textile 20, the warp yarns 102, 104 of the first system of warp yarns 121 only weave under the critical pics 132, 134, 136, 138 and the warp yarns 101, 103 of the second system of warp yarns 122 only weave over the critical pics 132, 134, 136, 138. As in the first embodiment of the industrial textile 20, each of the warp yarns 102, 104 in the first system of warp yarns 121 forms a locking weave after each float by weaving under one of the weft yarns 132, 134, 136, 138 over one of the weft yarns 131, 133, 135, 137 and under one of the weft yarns 132, 134, 136, 138. Similarly, the warp yarns 101, 103 of the second system of warp yarns 122 form a locking weave after each of the floats by weaving over one of the weft yarns 132, 134, 136, 138, under one of the weft yarns 131, 133, 135, 137, and over one of the weft yarns 132, 134, 136, 138. This provides enhanced stability for the fabric 120 which is also preferably woven with 100% warp fill in each of the first system of warp yarns 121 and the second system of warp yarns 122. The warp yarns 101-104 and the weft yarns 131-138 are similar to the warp yarns 1-16 and weft yarns 31-40 as described above in connection with the first embodiment of the industrial textile 20. As shown in Figure 3, this arrangement provides a diagonal twill on the first surface 124 of the industrial textile 120. A diagonal twill would also be provided on the second surface 126.

[0042] Referring now to Figures 5 and 6, a third embodiment of the industrial textile 120' is shown. The third embodiment of the industrial textile 120' is woven with the same repeating weave pattern as the second embodiment of the industrial textile 120 and similar elements have been marked with the same reference numbers as in the second embodiment with a prime. For example, the warp yarns 101' – 104' correspond to the warp yarns 101-104 in the second embodiment 120, and the weft yarns 131' – 138' correspond with the weft yarns 131-138 of the second embodiment 120. The primary difference is that based on the locking weave provided for the warp yarns 101'-104', the warp yarns 101'-104' in each of the layers are woven with less than 80% warp fill in order to provide an open mesh. In a preferred embodiment, the first system of warp yarns 121' is woven with approximately 50% warp fill and the second system of warp yarns 122' is also woven with

approximately 50% warp fill so that an open mesh dryer fabric as shown in Figure 5 can be produced. The stacked pairs of warp yarns 102', 101', and 104', 103', are maintained in position by their locking weave as discussed above in connection with the industrial textile 120. This allows for further applications of the industrial textiles according to the invention.

[0043] Preferably the industrial textiles 120, 120' are formed into endless belts by seaming at the warp ends as discussed above in connection with the first embodiment of the industrial textile 20. A preferred application for the industrial textile 120 is as a papermaking fabric, and in particular, a dryer fabric for a papermaking machine.

[0044] A preferred application for the industrial textile 120' is for use as a dryer fabric. However, those skilled in the art will recognize that there are other applications.

[0045] Referring to Figures 7 and 8, a fourth embodiment of an industrial textile 220 is shown. The industrial textile 220 is similar to the industrial textile 20 and includes first and second systems of warp yarns 221, 222 that are interwoven with a system of weft yarns 230. The arrangement is similar to the industrial textile 20 with the exception that the floats in the first warp system 221 are over seven of the weft yarns 231-242 and the floats in the second system of warp yarns 222 are under 7 of the weft yarns 231-242. The warp yarns 202, 204, 206, 208, 210, 212, 214, 216 of the first system of warp yarns 221 are woven in stacked pairs over the warp yarns 201, 203, 205, 207, 209, 211, 213, 215 of the second system of warp yarns 222 as shown. The warp yarn 202 weaves over weft yarns 231-237, under weft yarn 238 over weft yarn 239 and under weft 240. In a similar manner to the first embodiment, the weft yarns 232, 234, 236, 238, 240, 242 are critical pics having a smaller diameter than the filler wefts 231, 233, 235, 237, 239, 241. The warp yarn 201 of the second system of warp yarns 222, which is stacked under the warp yarn 202, weaves under weft yarn 231, over weft yarn 232, under weft yarn 233, over weft yarn 234, and then under weft yarns 235-242. The next stacked pair of warp yarns 204, 203 are woven with the warp yarn 204 extending over weft yarn 231, under weft yarn 232, over weft yarn 233, under weft yarn 234, and

over weft yarns 235-242. The warp yarn 203 which is stacked under the warp yarn 204 weaves under weft yarns 231-237 over weft yarn 238, under weft yarn 239, and over weft yarn 240, under weft yarn 241, and over weft yarn 242. The weave diagram in Fig. 7 shows the paths of the remaining stacked pairs of warp yarns in a clearly defined manner, and in this embodiment, the warp pattern repeats with warp yarns 205-208 having the same weave pattern as warp yarns 201-204. The stacked arrangement of warp yarns 201-216 extends across the fabric width. As in the industrial textile 20, the warp yarns 202, 204, 206, 208, 210, 214, 216 of the first system of warp yarns 221 only weave under the critical pics 232, 234, 236, 238, 240, 242 and the warp yarns 201, 203, 205, 207, 209, 211, 213, 215 of the second system of warp yarns 222 only weave over the critical pics 232, 234, 236, 238, 240, 242. As in the first embodiment of the industrial textile 220, each of the warp yarns 202, 204, 206, 208, 210, 212, 214, 216 in the first system of warp yarns 221 forms a locking weave after each float by weaving under one of the weft yarns 232, 234, 236, 238, 240, 242 over one of the weft yarns 231, 233, 235, 237, 239, 241 and under one of the weft yarns 232, 234, 236, 238, 240, 242. Similarly, the warp yarns 201, 203, 205, 207, 209, 211, 213, 215 of the second system of warp yarns 222 form a locking weave after each of the floats by weaving over one of the weft yarns 232, 234, 236, 238, 240, 242 under one of the weft yarns 231, 233, 235, 237, 239, 241 and over one of the weft yarns 232, 234, 236, 238, 240, 242. This provides enhanced stability for the fabric 220 which is also preferably woven with 100% warp fill in each of the first system of warp yarns 221 and the second system of warp yarns 222. The warp yarns 201-216 and the weft yarns 231-242 are similar to and can have the same constructions as the warp yarns 1-16 and weft yarns 31-40 as described above in connection with the first embodiment of the industrial textile 20. As shown in Figure 7, this arrangement provides a diagonal twill on the first surface 224 of the industrial textile 220. A diagonal twill would also be provided on the second surface 226.

[0046] Fig. 9 shows a further alternative embodiment of a high stability industrial textile 320 is shown. The industrial textile 320 includes first and

second systems of warp yarns 321, 322 that are interwoven with a system of weft yarns 330. Here, the floats in the first warp system 321 are over at least 5, and preferably over seven of the weft yarns 331-338 and the floats in the second system of warp yarns 322 are under at least 5 and preferably under 7 of the weft yarns 331-338. The warp yarns 301-316 are woven in adjacent pairs that are stacked. Adjacent warp yarns 303, 304 are arranged on the first surface 324 and are woven along the same path over at least 5 of the weft yarns 331-338, and are stacked over adjacent warp yarns 301, 302 which are arranged on the second surface 326 and are woven along the same path under at least 5 of the weft yarns 331-338. Adjacent first surface warp yarns 307, 308 are also woven along the same path and are stacked over adjacent second surface warp yarns 305, 306 which are woven along the same path. Similarly, adjacent first surface warp yarns 311, 312 are also woven along the same path over at least 5 of the weft yarns 331-338 and are stacked over adjacent second surface warp yarns 309, 310 that are woven along the same path under at least 5 of the weft yarns, and adjacent first surface warp yarns 315, 316 are also woven along the same path over at least 5 of the weft yarns 331-338 and are stacked over adjacent second surface warp yarns 313, 314 that are woven along the same path under at least 5 of the weft yarns. The weave diagram in Fig. 9 shows the repeat, and in this example, the warp yarn floats are over/under 7 of the weft yarns 331-338. Based on the paired arrangement of the warp yarns 301-316 in the first surface 324 and the second surface 326, a distinct double float arrangement is provided with a distinct diagonal twill. As shown, the warp yarns 303, 304 of the first system of warp yarns 321 weave over weft yarns 331-337, and under weft yarn 338. The warp yarns 301, 302 of the second system of warp yarns 322, which are stacked under the warp yarns 303, 304, weave under weft yarns 331-333, over weft yarn 334, and under weft yarns 335-338. The next adjacent pair of warp yarns 307, 308 are woven as an adjacent pair over weft yarns 231-233, under weft yarn 234, and over weft yarns 235-238. The adjacent warp yarns 205, 206 which are stacked under the warp yarns 207, 208 weave under weft yarns 231-237, and over weft yarn 238. The arrangement of adjacent warp yarns 311, 312 of the first system

of warp yarns 321 over adjacent warp yarns 309, 310 of the second system of warp yarns 322, as well as the arrangement of adjacent warp yarns 315, 316 of the first system of warp yarns 321 over adjacent warp yarns 313, 314 of the second system of warp yarns 322 are similar. The interweaving of the warp yarns of the first and second systems of warp yarns 321, 322 is only with critical pics 332,334, 336, 338, and not with the filler wefts 331, 333, 335, 337. Preferably the warp fill is about 200% warp fill, with each layer having warp yarns woven at about 100% warp fill. This contributes to the stability of the industrial textile 320 and helps to resist creasing and distortion due to the fact that the warp yarns 301-316 in each layer are woven at about 100% warp fill, and thus are immediately adjacent to and braced against one another.

[0047] In order to provide for smooth first and second surfaces 24, 26, of the fabric 20, as well as the first and second surfaces 124, 126; 124', 126'; 224, 226; 324, 326 of the industrial textiles 120, 120', 220, 320 preferably, the filler wefts 31, 33, 35, 37, 39; 131, 133, 135, 137; 131', 133', 135', 137'; 231, 233, 235, 237, 239, 241; 331, 333, 335, 337 have a diameter D1 and the smaller critical pics 32, 34, 36, 38, 40; 132, 134, 136, 138; 132', 134', 136', 138'; 232, 234, 236, 238, 240, 242; 332, 334, 446, 338 have a diameter D2 which is smaller than D1, and the warp yarns 1-16, 101-104, 101'-104', 210-216, 301-316 have a rectangular cross-section with a thickness t. Preferably,  $(D1 - D2)/2 \approx 2t$ . This provides for generally smooth first and second surfaces in the industrial textiles 20, 120, 120', 220, 320. In one exemplary embodiment D1 = 0.90mm, D2 = 0.60mm and t = 1.55mm. Those skilled in the art will recognize that other dimensions could be used depending on the particular application.

[0048] Having thus described the present invention in detail, it is to be appreciated and will be apparent to those skilled in the art that many physical changes, only a few of which are exemplified in the detailed description of the invention, could be made without altering the inventive concepts and principles embodied therein. It is also to be appreciated that numerous embodiments incorporating only part of the preferred embodiment are possible which do not alter, with respect to those parts, the inventive concepts and principles embodied therein. The present embodiment and optional

configurations are therefore to be considered in all respects as exemplary and/or illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all alternate embodiments and changes to this embodiment which come within the meaning and range of equivalency of said claims are therefore to be embraced therein.

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## CLAIMS

1. An industrial textile having first and second surfaces, the textile comprising:

first and second systems of warp yarns interwoven with a system of weft yarns in a repeating pattern in which:

each of the warp yarns in the first system of warp yarns is interwoven with the system of weft yarns on the first surface over at least 5 of the weft yarns, under 1 of the weft yarns, over 1 of the weft yarns, and under 1 of the weft yarns in the repeating pattern forming a float on the first surface over the at least 5 of the weft yarns,

each of the warp yarns in the second system of warp yarns is interwoven with the system of weft yarns on the second surface under at least 5 of the weft yarns, over 1 of the weft yarns, under 1 of the weft yarns and over 1 of the weft yarns in the repeating pattern forming a float on the second surface under the at least 5 of the weft yarns, and

each of the warp yarns of the first system of warp yarns is stacked over a corresponding one of the warp yarns of the second system of warp yarns to form stacked pairs of the warp yarns.

2. The industrial textile of claim 1, wherein the float on the first surface is over 7 weft yarns, and the float on the second surface is under 7 weft yarns.

3. The industrial textile of claim 1, wherein the system of weft yarns includes alternating larger diameter filler wefts and smaller diameter critical picks.

4. The industrial textile of claim 3, wherein the warp yarns of the first system of warp yarns only weave under the critical picks, and the warp yarns of the second system of warp yarns only weave over the critical picks.

5. The industrial textile of claim 1, wherein the repeating pattern of the warp yarns of the first system of warp yarns of under 1 of the weft yarns, over 1 of the weft yarns, and under 1 of the weft yarns forms a locking weave for

maintaining a position of the warp yarns of the first system of warp yarns, and the repeating pattern of the warp yarns of the second system of warp yarns of over 1 of the weft yarns, under 1 of the weft yarns, and over 1 of the weft yarns forms a locking weave for maintaining a position of the warp yarns of the second system of warp yarns.

6. The industrial textile of claim 1, wherein the stacked pairs of the warp yarns are spaced apart to form an open mesh pattern.

7. The industrial textile of claim 6, wherein the stacked pairs of the warp yarns are spaced apart by at least 40% of a cross-direction dimension of one of the warp yarns.

8. The industrial textile of claim 1, wherein the floats on the first surface are arranged with a diagonal twill.

9. The industrial textile of claim 1, wherein the first system of warp yarns is made from a different material than the second system of warp yarns.

10. The industrial textile of claim 1, wherein the warp yarns of the first and second systems of warp yarns have a rectangular cross-section.

11. The industrial textile of claim 10, wherein the cross-section of the warp yarns of the first and second systems of warp yarns are the same.

12. The industrial textile of claim 10, wherein the weft yarns have a circular cross-section.

13. The industrial textile of claim 12, wherein the system of weft yarns includes alternating larger filler wefts having a diameter  $D_1$  and smaller critical picks having a diameter  $D_2$ , the warp yarns of the first and second

systems of warp yarns with the rectangular cross-section have a thickness  $t$ , wherein  $D1 > D2$ , and  $(D1 - D2)/2 \approx t$ .

14. The industrial textile of claim 1, wherein the first system of warp yarns and second systems of warp yarns each have at least 100% warp fill.

15. The industrial textile of claim 1, wherein the first and second systems of warp yarns are woven with 8 sheds in 10 steps.

16. The industrial textile of claim 1, wherein the industrial textile is a papermaking fabric.

17. The industrial textile of claim 1, wherein the industrial textile is a dryer fabric for a papermaking fabric.

18. An industrial textile having first and second surfaces, the textile comprising:

first and second systems of warp yarns interwoven with a system of weft yarns in a repeating pattern in which:

adjacent pairs of the warp yarns in the first system of warp yarns are interwoven along a same path with the system of weft yarns on the first surface over at least 5 of the weft yarns and under 1 of the weft yarns in the repeating pattern forming adjacent pairs of floats on the first surface over the at least 5 of the weft yarns,

adjacent pairs of the warp yarns in the second system of warp yarns are interwoven along a same path with the system of weft yarns on the second surface under at least 5 of the weft yarns and over 1 of the weft yarns in the repeating pattern forming adjacent pairs of floats on the second surface under the at least 5 of the weft yarns, and

the adjacent pairs of warp yarns of the first system of warp yarns are stacked over corresponding ones of the adjacent pairs of warp yarns of the second system of warp yarns to form stacked, adjacent pairs of the warp yarns.

19. The industrial textile of claim 18, wherein the system of weft yarns includes alternating larger diameter filler wefts and smaller diameter critical picks.

20. The industrial textile of claim 19, wherein the warp yarns of the first system of warp yarns only weave under the critical picks, and the warp yarns of the second system of warp yarns only weave over the critical picks.

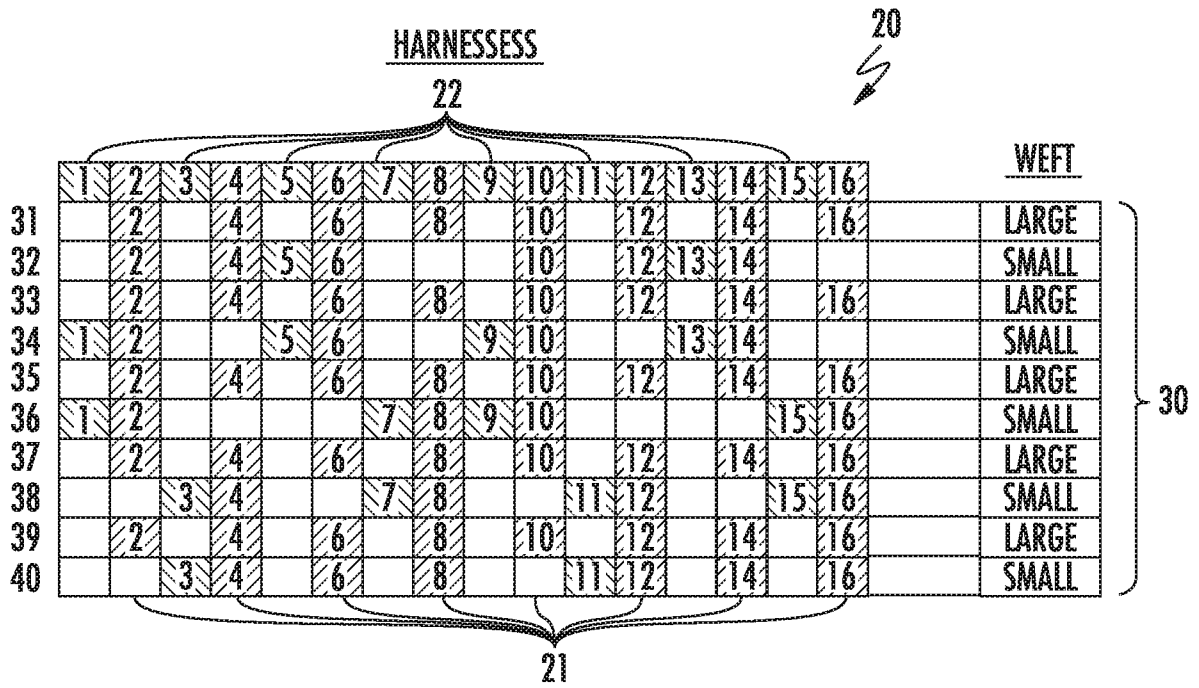


FIG. 1

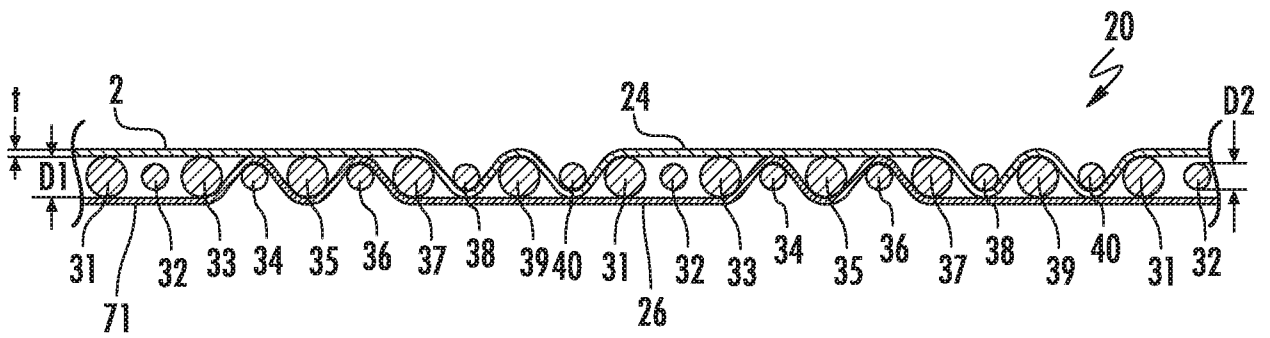


FIG. 2

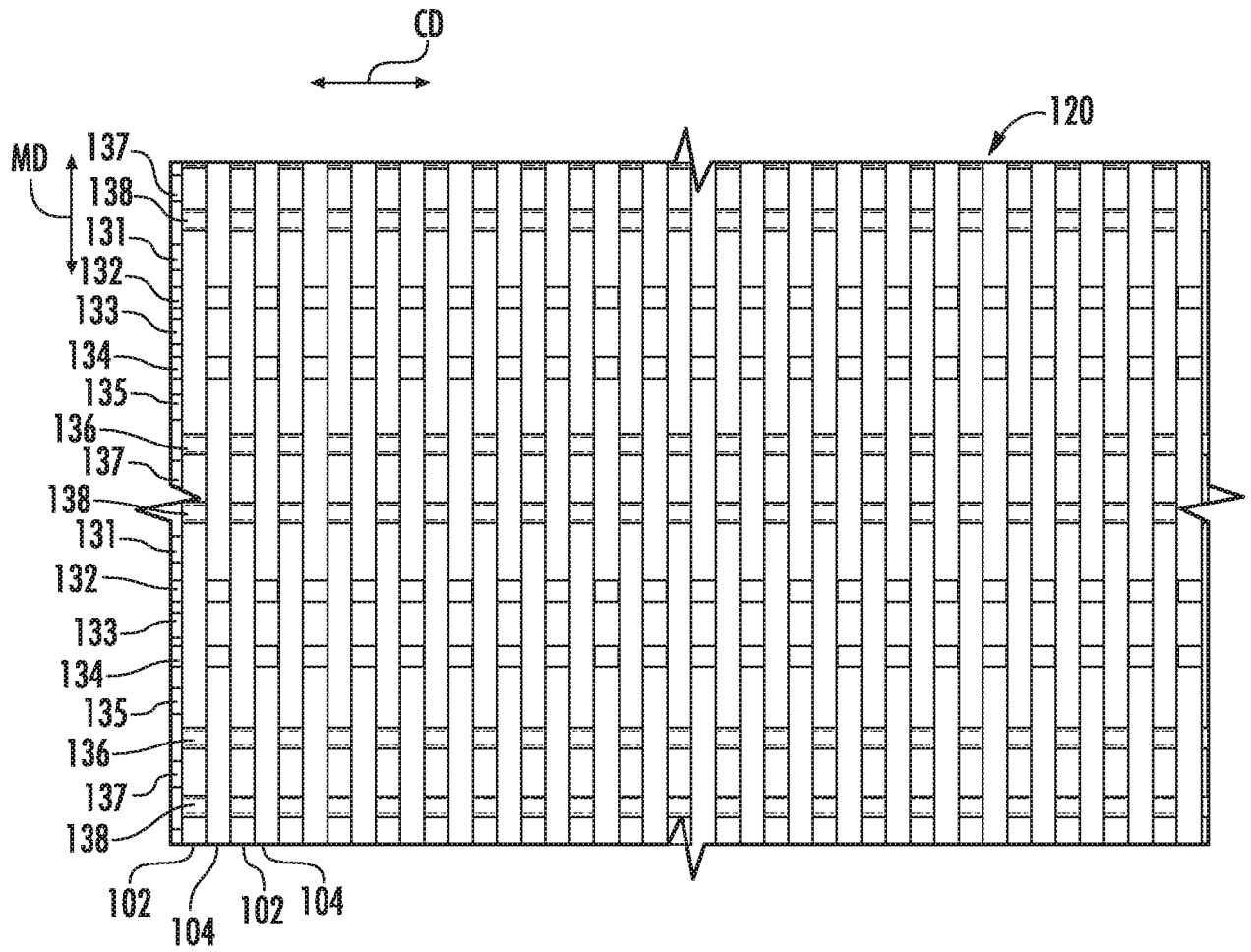


FIG. 3

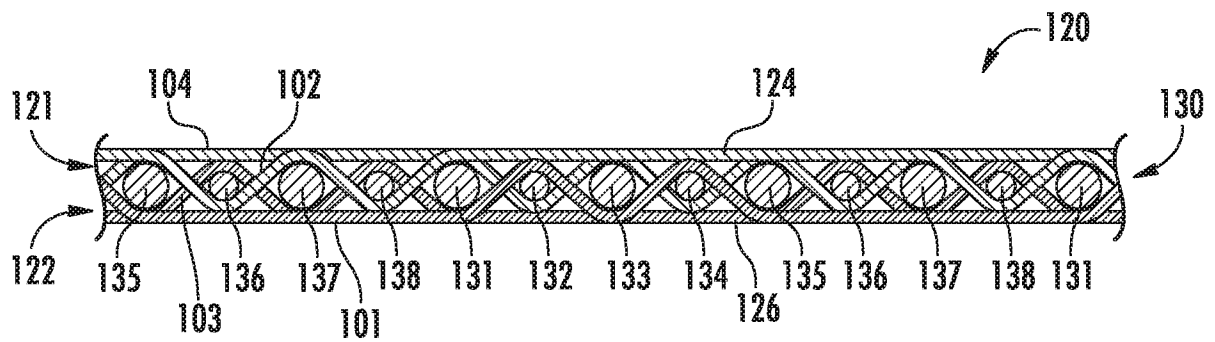


FIG. 4

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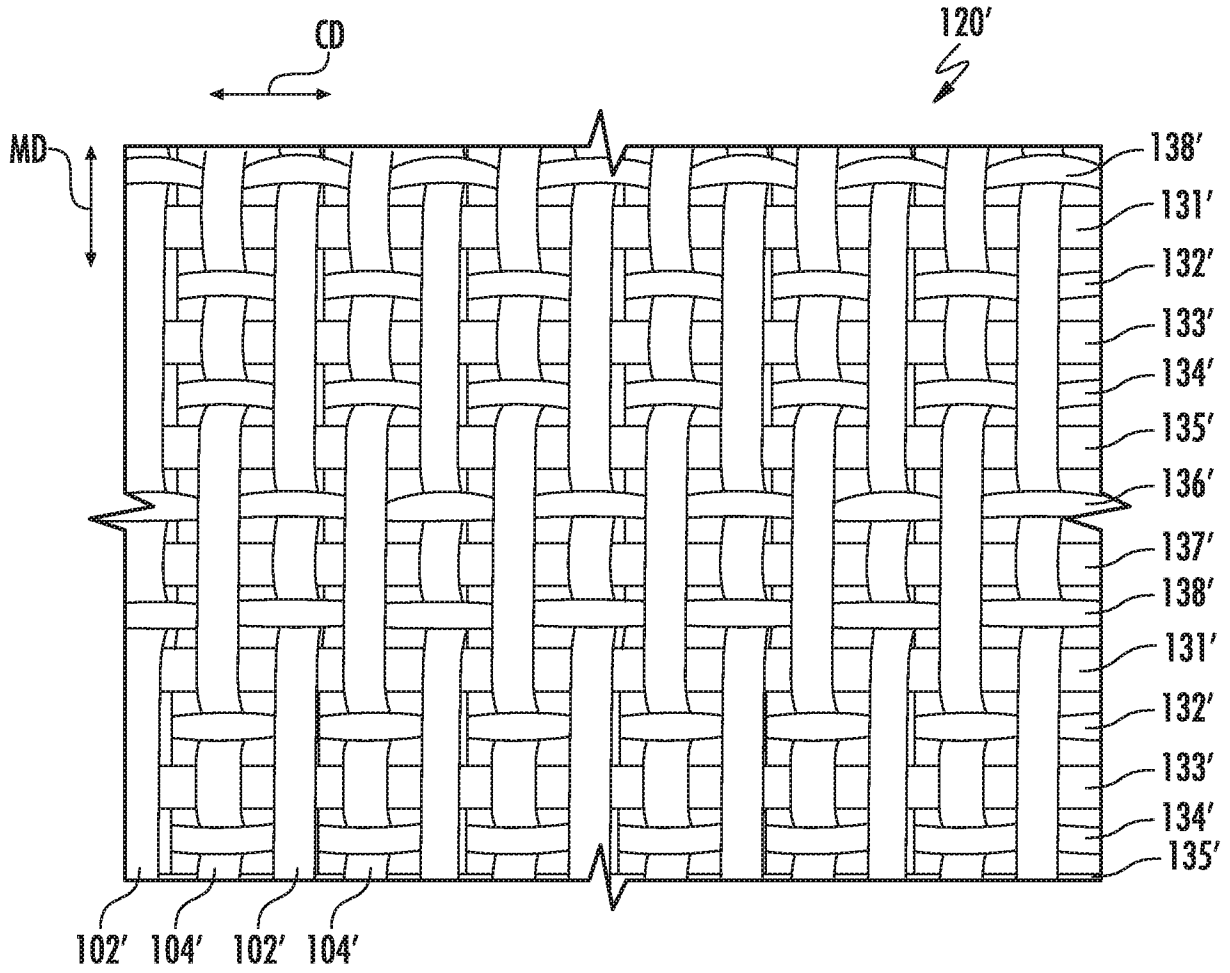


FIG. 5

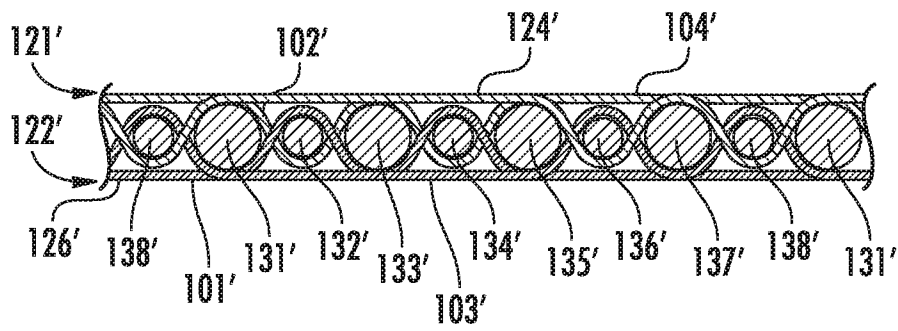
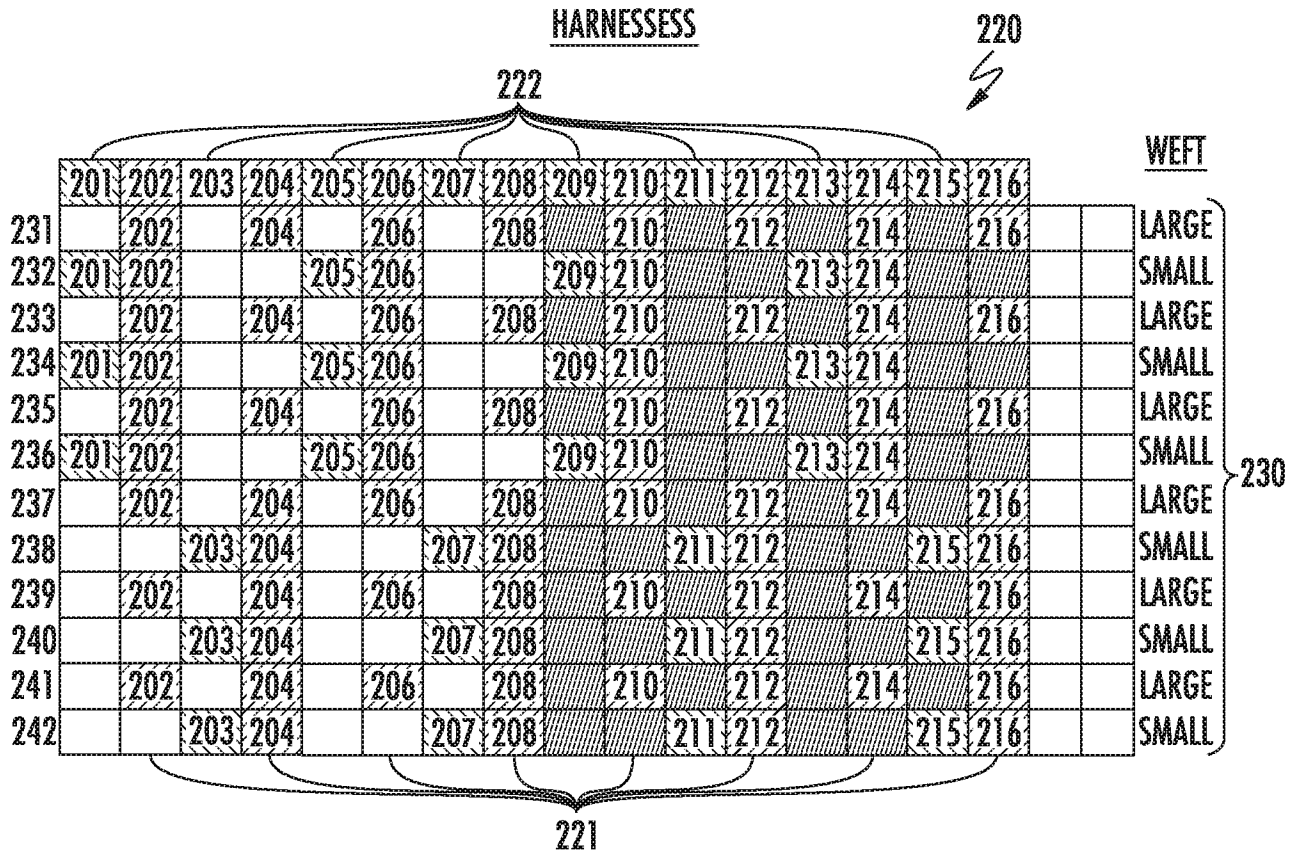
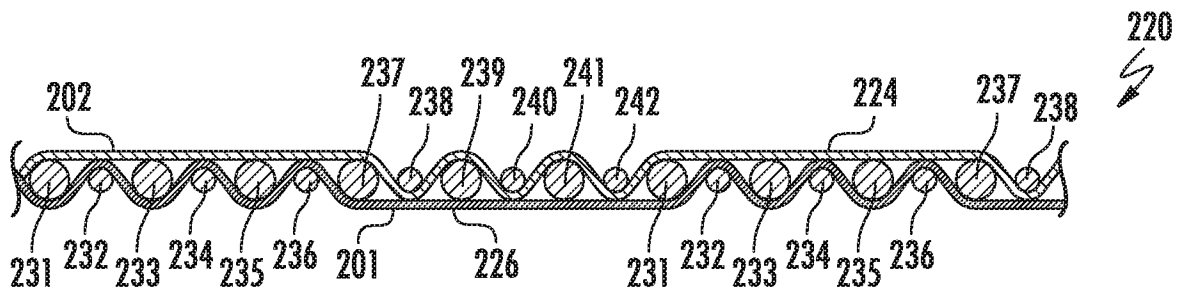


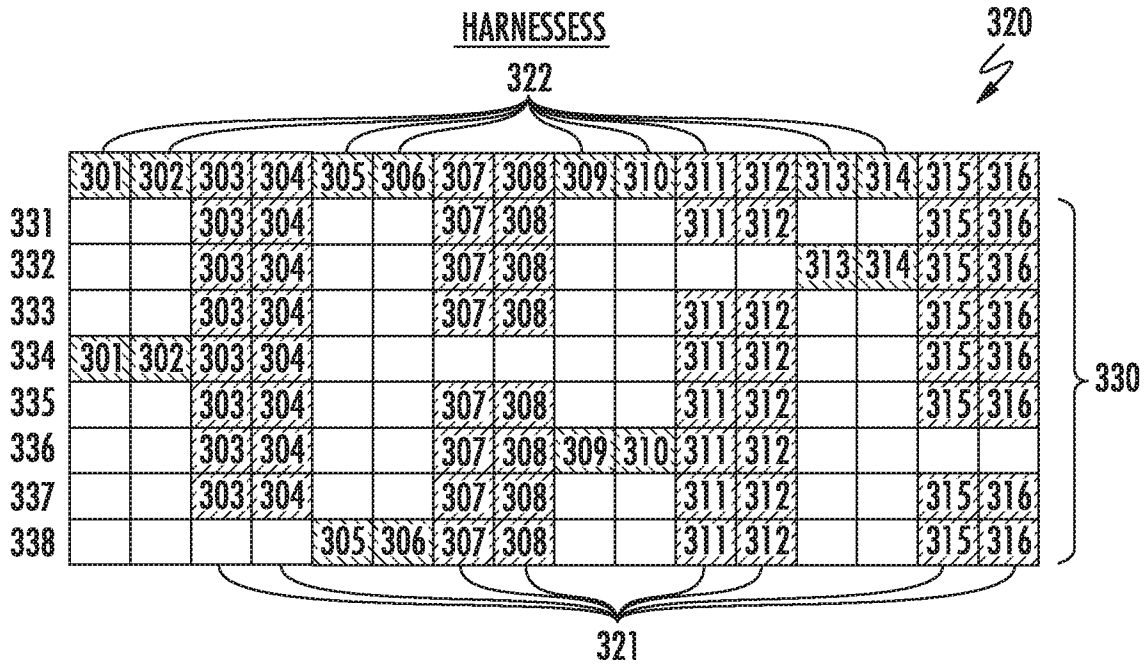
FIG. 6



**FIG. 7**



**FIG. 8**



**FIG. 9**