APPARATUS FOR CROSSLAYING WEB MATERIALS

Inventor: William H. Burger, Neenah, Wis.
Assignee: Kimberly-Clark Corporation, Neenah, Wis.
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A method and apparatus for efficiently handling and crosslaying webs of substantially aligned light-weight fibers in the production of non-woven materials incorporating such crosslaid fibers for two-dimensional strength. Webs of substantially aligned fibers are conveyed along a first permeable carrier with their fibers oriented in the direction of travel and are transferred to a second moving permeable carrier crossing in closely spaced parallel relation by directing an air flow through said permeable carriers when each web length reaches the position between the crossing carriers. The air flow causes the light-weight web length to be removed from the first carrier and to be positioned and held against the other moving carrier with the web fibers oriented thereon transversely to the direction of travel. The illustrated apparatus includes two such carrier systems for changing the orientation of web lengths with respect to their direction of travel, and these systems alternately present web lengths to a continuous moving fiber web to form an uninterrupted ply of crosslaid fibers thereon. Two adhesively coated cover sheets are then applied to contain the crosslaid fibers and form a composite non-woven material.

6 Claims, 5 Drawing Figures
APPARATUS FOR CROSSLAYING WEB MATERIALS

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DESCRIPTION OF THE INVENTION

The present invention relates generally to non-woven materials having crosslaid fibers and more particularly concerns an improved method and apparatus for making such non-woven materials.

In the manufacture of non-woven materials it is often desirable to apply fibers in transverse directions to give two-dimensional strength to a composite material. In the past it has been difficult to handle such fibers or webs of such fibers due to their light weight and fragile character.

It is a primary object of the present invention to provide an improved and efficient method and apparatus for handling and crosslaying light-weight fibers in the production of a composite non-woven material.

Another object is to provide an efficient and reliable means for transferring a web of substantially aligned fibers from one moving carrier on which the fibers are oriented in the direction of travel to another moving carrier with the web fibers positioned on that carrier transversely to the direction of travel, while not rearranging or damaging the individual web fibers.

Other objects and advantages of the invention will become more apparent upon reading the following detailed description and upon reference to the accompanying drawings, wherein:

FIG. 1 is a schematic top view of apparatus embodying the present invention;

FIG. 2 is a schematic side elevation of the apparatus of the present invention taken in the plane of line 2-2 in FIG. 1;

FIG. 3 is a schematic perspective view of one of the air pressure units employed in the apparatus shown in FIG. 1, with the parts separated for illustrative purposes;

FIG. 4 is a schematic elevation view taken in the plane of line 4-4 in FIG. 1;

FIG. 5 is a plan view of a finished material manufactured by the illustrated apparatus with sections of the individual layers broken away to show the multi-component construction.

While the invention is susceptible of various modifications and alternative constructions, certain illustrative embodiments thereof have been shown in the drawings and will be described below in detail. It should be understood, however, that there is no intention to limit the invention to the specific forms disclosed, but, on the contrary, the intention is to cover all modifications, alternative constructions and equivalents falling within the spirit and scope of the invention.

Turning now to the drawings, the invention is exemplified in an apparatus for forming a non-woven composite material having highly oriented crosslaid fibers therein. In the illustrative apparatus, multiple slivers of textile fibers are drawn from their respective supply cans 11 over a guide comb 12 and in juxtaposed relation into a draw frame 14 which comprises a series of pairs of rolls 15 and 16. The rolls of each pair are driven by appropriate gearing well known in the art at a peripheral rate of speed faster than the rate of rotation of the preceding roll pair. As the juxtaposed slivers pass through the draw frame 14, the individual fibers are drafted and spread out to form a flat striated web of substantially aligned fibers as indicated at 18. The fiber web 18 has a principal strength component, or direction of strength, in the direction of the fiber alignment, while it is substantially deficient in cross direction strength. While the illustrated method and apparatus will be described in connection with such highly drafted fiber webs, it will be understood that other light-weight fragile webs could similarly be employed.

The web 18 while still under tension may next be separated into discrete lengths or segments 44, 45. In the illustrated arrangement, the web is drawn between a knife roll 19 and anvil roll 20. A knife blade 21 positioned on the periphery of the knife roll 19 severed the web 18 into equal lengths 44, 45 upon each revolution of the roll. It is apparent that the length of the web is determined by the circumference of the knife roll. In this case, the web 18 is cut into lengths equal to the width of the web, although one skilled in the art will understand that other rectangular proportions could be used.

As the web is being severed by the knife roll 19, the forward end of the length of web has been drawn between two moving carriers 24, 25, containing web material, such as fourdrinier wires. Carrier 24 is trained around a guide roll 26 adjacent the anvil roll 20, a screen roll 28, a drum 29 in juxtaposed relation to the screen roll 28, and guide rolls 30, 31, 32. The second carrier 25 is trained about a guide roll 34 adjacent the knife roll 19, a screen roll 35 immediately adjacent the screen roll 28, a drum 36 in juxtaposed relation to the screen roll 35, and a guide roll 38. Still another permeable carrier 39 runs immediately adjacent the carrier 25 while being trained about the drum 36 and screen roll 35, and then continues around the guide rolls 40, 41 and 42. As can be seen, cut lengths of web are drawn between the carriers 24, 25 and are conveyed toward the screen rolls 28, 35.

In keeping with the invention, the screen rolls 28, 35 are adapted to direct alternate web lengths 44 along a lower carrier system 70 comprising carriers 24, 71, and 72 and alternate lengths 45 along an upper carrier system 74, comprising carriers 25, 39, 75 and 76. To this end, each screen roll 28, 35 has a screen portion 46, 48, respectively, making up half the circumference, the other half of each roll being made of nonpermeable material, and suction is applied internally of each roll in any well known manner. The screen rolls 28, 35 each may have a circumference equal to twice the length of the web segments 44, 45 so that the circumferential suction portions 46, 48 equal the length of the web segment. By appropriately driving the screen rolls so that they rotate 180° out of phase with each other, the suction portions 46, 48 will draw alternate cut web lengths 44, 45, respectively, against the screen roll and direct them along their associated carriers 24, 25. Rotation of the screen rolls 28, 35 may be timed so that the suction portion of one roll reaches the nip position between the rolls at the same time the leading edge of a web reaches that position.

It should be appreciated that while in the illustrated embodiment a knife roll 19 has been shown for severing the web 18 into determined lengths 44, 45, separation of the web in the form of the rolls may be affected by other means. For example, since the web generally is quite fragile, severing of the web may be achieved di-
rectly by the suction screen rolls 28, 35. In that case, the draw frame 14 would feed the web 18 directly between the carriers 24, 25 and the suction portions 46, 48 of the screen rolls 28, 35 would engage alternate sections of the web with the web being pulled apart every time the suction portion of one roll passes by the nip between the rolls and the suction portion from the other roll began to act on the web. Since the web fibers are relatively short, the web would be separated with a substantially clean and even break. The web segments similarly would have lengths corresponding to the circumferential distance of the screen roll suction portion and would be directed to alternate carriers.

After engagement of alternate web lengths 44, 45 by the suction screen rolls 28, 35, the web lengths continue to travel along the respective carriers 24, 25. The web lengths 45 engaged by the suction portion 48 of the upper screen roll 35 are conveyed upward around the screen roll 35 and drum 36 while being interposed between the carriers 25 and 39. When the web length 45 reaches the top of the drum 36, it is then conveyed away from the drum 36 by the carriers 25 and 39. The alternate web lengths 44 engaged by the lower suction screen roll 28 travel downward about the screen roll 28 and drum 29 and are then conveyed away from the drum 29 by the carrier 24. In each case, the aligned fibers of the web lengths are oriented in their direction of travel.

In keeping with the invention, the web lengths each are transferred from the permeable carrier on which they are being conveyed to another moving permeable carrier crossing closely parallel to the first carrier with the webs being positioned on said other carrier with their fibers oriented transversely to the direction of travel of that carrier. To effect a reliable and efficient transfer of the webs without disorienting or damaging the web fibers, each web length is carried to a position directly below and in close relation to the other moving carrier and air flow is directed through the permeable carriers causing the web to be removed from the first carrier and be positioned and held against the other moving carrier by the upper carrier system 74 of the illustrated embodiment, as best shown in FIGS. 2 and 4, the carrier 75 which also is made of a permeable material such as fourdriner wire, is disposed about guide rolls 79, 80, 81, and 82 so that it crosses the carrier 39 in close parallel relation therewith. Thus, the carrier 39 can convey each web length 45 to a position directly under the other moving carrier 75, at which time an upward surge or air may be passed through the carriers 39, 75 to effect the transfer.

To provide a controlled flow of air through the permeable carriers 39, 75 in timed sequence with each web length 45 reaching the position directly between the carriers, air units 50 and 53 are positioned on opposite sides of the carriers 39, 75, respectively; each air unit having air emission grate surfaces immediately adjacent its respective carrier. In the illustrated embodiment the lower air unit 50, shown in detail in FIG. 3, comprises an extension portion 51 having an upper grate 52 and a main body portion 54 having a grate surface 55 of approximately the same size as the web lengths 45. The air unit 50 is adapted to create a constant suction pressure at the extension grate 52 to hold a web length 45 firmly against the carrier as it approaches the closely spaced crossing carrier 75, while providing a regulated alternating updraft and downdraft at the main grate 52 to effect the transfer. The unit 50 includes a base 56 having a lower chamber 57 with a main opening 58 on one side communicating with a duct 59 and apertures 60 in another side communicating with the interior of the extension portion 51. A suction pressure source connected to the duct 59, as will be explained below, creates a constant suction or downdraft at the extension grate 52.

To provide an alternating pressure at the main grate 55, the base 56 is formed with a series of parallel vertical baffles 61, the top portion of each baffle being open to form apertures 62 which permit communication with the lower chamber 57. Air passageways 63 are defined between the baffles 61. To control the direction of the air flow through the grate 55, a shutter plate 64 having a series of aligned apertures 65 is slidably positioned on the top surface of the baffles 61 with the main grate 55 positioned over the shutter 64. A duct 66 attached to the side of the base 56, above the duct 59, connects the passageways 63 between the baffles 61 to a positive pressure source, which also will be explained below. By slightly shifting the shutter 64 to a downdraft or suction position, the shutter apertures 65 are in alignment with the baffle apertures 62 while the passageways 63 between the baffles are closed by the shutter. In that position, suction in the duct 59 draws through the lower chamber 57, baffle apertures 63, shutter apertures 65 and the grate 55. When the shutter 64 is shifted to an updraft or positive pressure position, the shutter apertures 65 are in alignment with the air passageways 63 and the baffle apertures 62 are closed by the shutter. A draft therefore is created through the duct 66, passageways 63, shutter apertures 65 and out through the grate 55. An actuating mechanism 68, controlled by well known means, may slightly move the shutter 64 between the downdraft and updraft positions at determined intervals.

The other air unit 53, being of the same basic construction as the unit 50, need not be described in detail. The unit 53 similarly has an extension grate 84 subjected to a constant suction or downdraft and a main grate 85 subjected to alternating outward and inward air flows. Ducts 86, 88 extend from a suction chamber and baffle region, respectively, similar to those described above.

As shown in FIG. 2, a conduit 89 connects the duct 59 extending from the lower chamber 57 of the air unit 50 to the duct 88 at the baffle region of the other unit 53. Another conduit 90 connects the duct 66 at the baffle region of the unit 50 with the duct 86 at the suction chamber of the other unit 53. To create appropriate pressures in the ducts, a power fan 91, 92 is enclosed within each conduit 89, 90, respectively. It can be seen that by directing the air flow from fan 92 within the conduit 90 toward the duct 66 extending from the baffle region of the air unit 50 a positive pressure build-up will be created in the air passageways 63 between the baffles 61 and a negative or suction pressure will be created in the suction chamber of the air unit 53. By directing the fan 91 contained in the conduit 89 in the opposite direction a positive pressure is created in the baffle passageways of the unit 53 and a suction pressure in the chamber 57 of the unit 50, as shown by the direction arrows.

It will be appreciated that the illustrated air units 50, 53 may be operated simultaneously by an appropriate actuating means so that when the shutter for the unit
50 is in an updraft position the shutter for the other unit is in a suction position so that a steady upward flow of air is directed through main air unit grates 55, 85, and thus through the area where the permeable carrier 75 crosses the carrier 39. Likewise, when the shutter for the unit 50 is in its suction position, the shutter for the unit 53 is in its outdraft position causing a steady downward flow of air through the permeable carriers 39, 75.

In operation, as a web length 45 passes over the extension grate 52 of the unit 50, the constant suction pressure existing at the grate 52 acts through the permeable carrier 53 causing the web to be held closely to the carrier as it approaches the position where the carrier 75 crosses in close parallel relation to the first carrier. When the leading edge of the web length 45 reaches the main air grate 55, the air unit shutters are simultaneously actuated so that a steady downdraft is created through the permeable carriers 39, 75, causing the web length 45 to remain in close contact with the carrier 39 as it is conveyed between the carriers. As the web segment 45 reaches a position completely over the main grate 55, and thus directly under the transversely moving carrier 75, the shutters for the air units 50, 53 are simultaneously shifted to change the air flow from a downdraft to an updraft, causing the web length 45 to be lifted from the carrier 39 and be forced against the moving carrier 75 with the web fibers thus oriented transversely to the direction of travel of the carrier 75.

It has been found that the rapid reversal of air flow achieved by the cooperating air units 50, 53 achieves an efficient and uniform transfer of the web lengths from the first moving carrier to the other without disarrangement or damage to the web fibers. The updraft from the main air grates 55, 85 continues to hold the web length 45 firmly against the carrier 75 as the web length is conveyed by the carrier away from the grate 85. The constant suction pressure existing at the extension grate 84 of the upper air unit 53 further holds the web length 45 against the carrier 75 until the leading edge of the length reaches a nip between the carrier 75 and an auxiliary carrier 76 through which it is drawn. When the trailing edge of the web length 45 has been conveyed past the upper main grate 85, the leading edge of the length is formed by drawing air from the lower air grade 50, and at that time, the actuating mechanism will again shift the shutters to reverse the direction of airflow to cause a downdraft through the carriers 39, 75 as the next web length passes over the lower main grate 55 to repeat the cycle.

It will be appreciated that the spacing between the web lengths 45 carried by the carrier 39 results from alternately directing the web lengths 44, 45 along the two carrier systems 70, 74. While in the illustrated embodiment, the web segments are substantially square so that the carriers 39, 75 would have equal speeds, it will be understood by one skilled in the art that other rectangular sizes of web segments could be employed by making appropriate adjustments in the carrier speeds.

Since the web lengths 45 are positioned on the crossing carrier 75 with their fiber alignment oriented transversely to the direction of travel of that carrier, they are conveyed onto the auxiliary carrier 76 with a similar fiber orientation. The auxiliary carrier 76, being trained about guide rolls 94 and 95 conveys the web lengths 45 at spaced intervals to a position for engagement by a screen roll 96, which completes the travel of the web length 45 through the upper carrier system 74.

The web lengths 44 directed along the lower carrier system 70 incur a somewhat similar course of travel, being conveyed along the carrier 24 with their web fibers aligned in the direction of travel and then being transferred to another moving carrier 71 with the fibers oriented transversely to the direction of travel of that carrier. Again referring to FIGS. 2 and 4, each alternative web length 44 is conveyed by the carrier 24 to a position where the carrier 71, which crosses in close parallel relation therewith. The carrier 71 is trained about guide rolls 97a, 97b, 97c and 97d.

To effect the transfer of the web length 44 from the carrier 24 to the transversely moving carrier 71, air units 98, 99 are disposed on opposite sides of the carriers 24, 71 in a manner identical to that described above. As the web length 44 is conveyed over an extension grate 100 of the unit 98, a constant suction pressure existing at the grate 100 acts through the permeable carrier 24 to draw the web length 44 closely to the carrier. The web length 44 remains firmly on the carrier 24 as it is conveyed to a position directly under the transversely moving carrier 71 by a downward flow of air through main air grates 101, 102 of the units 98, 99, respectively. When the web length is in proper position between the carriers 24, 71, a simultaneous reversal of air direction through the main air grates 101, 102 causes the web length to be lifted from the carrier 24 and be held firmly against the moving carrier 71, which has a direction of travel transverse to the web fiber alignment. A constant suction pressure existing at an extension grate 104 of the unit 99 retains the web length 44 against the carrier until it reaches on auxiliary carrier 72 and is drawn through a nip between the carriers 71, 72. The auxiliary carrier 72, which is trained about guide rollers 105, 106 and 108, receives the web lengths 44 at spaced intervals for travel in a direction transverse to their fiber alignment.

In keeping with the invention, the web lengths 44, 45 are crosslaid on another moving medium to form a twoply, non-woven material. In the illustrated embodiment, the web lengths 44, 45 are placed alternately on a moving continuous fiber web 110 having fibers aligned in the direction of the web travel. The web 110 is made by drawing multiple slivers of textile fibers 111 from their respective supply cans 112, over a guide comb 114, and into a drawn frame 115 which forms the flat striated web 110 of aligned fibers similar to the web described above. From the draw frame 115, the web 110 is drawn between a nip formed by the auxiliary carrier 72 and a carrier 116, which is trained around guide rolls 118, 119, 120 with the auxiliary carrier guide roll 105 acting as a direction roll and creating the nip. The continuous web 110 is then drawn around the auxiliary carrier guide roll 105 and is moved along with the auxiliary carrier 72. The carrier 71 deposits the web lengths 44 at spaced intervals on the continuous web 110 with the fibers of the lengths 44 being oriented transversely to the fibers of the continuous web 110. The continuous web 110 and the crosslaid web lengths 44 are then conveyed toward the screen roll 96 where the web lengths 45 are positioned in the spaces between the lengths 44 to complete a substantially uniform ply of crosslaid fibers over the continuous web 110.

To facilitate proper positioning of the web lengths 45 on the continuous web 110, the screen roll 96 is provided with a constant suction pressure acting over the
configuration distance 121 between the auxiliary carriers 76 and 72 so that each web length 45 is held against the rotating screen roll as it is carried over the distance 121 and is guided onto the continuous web 110 moving with the carrier 72. In the illustrated apparatus, the suction pressure is limited to the circumferential distance 121 by appropriate stationery radial vanes 122, 124 which define a suction chamber encompassing the distance 121. It can be seen that each web carried by the screen roll 96 from the carrier 76 to the carrier 72 is released from a suction pressure as it passes the stationery vane 124.

It will be understood by those skilled in the art that by providing the distance of travel through the upper carrier system equal to the distance of travel through the lower carrier system, or otherwise by appropriately controlling the carrier speeds, the web lengths 44 and 45 may be made to alternate reach the nip of the screen roll 96 and carrier 72 so that the web lengths 45 are placed in and fill the spaces between the web lengths 44 already positioned on the continuous web 110. It will be appreciated that due to the very thin nature of the fiber webs 44 and 45, however, any small amount of overlapping that may exist between web lengths 44, 45 will have no noticeable effect in a finished product.

In the illustrated embodiment, the continuous web 110 and crosslaid web lengths 44, 45 are next drawn from the carrier 72 through a pair of rollers 125, 126 and incorporated between cover sheets of elongated material to form a composite non-woven material. As shown in FIG. 4, a sheet of elongated material 128, such as a creped wadding sheet which has been stretched and ironed to facial tissue softness, is drawn around the lower roller 125 from a supply roll 129. An offset printing roll 130 is located between the roller 125 and supply roll 129 and a metered amount of adhesive is applied to the roll 130 from an application roll 131 rotatably disposed in an adhesive drip pan 132. Excessive adhesive is wiped from the application roll with a suitable doctor blade 134. The application roll 131 preferably is an intaglio print roll having a substantially open spaced pattern, such as a diamond pattern. The total area occupied by the adhesive preferably should not exceed more than 25 percent of the total area of the final product. The adhesively printed sheet 128 is drawn around the guide roll 125 with the fibers of the crosslaid webs 110, 44, 45 impinging against the adhesive surface of the sheet and becoming partially embedded therein. An elongated creped wadding sheet 135 from a supply roll 136 similarly is printed with an adhesive by a printing roll 138 and is drawn around the upper guide roll 126 and applied to the opposite side of the crosslaid fiber webs to form a composite laminated sheet 140.

The composite sheet 140 thus formed is drawn from the rollers 125, 126 and around a heating drum 141 where curing of the adhesive is substantially completed to a non-tacky condition while the web fibers are in firm contact therewith. To provide a maximum curing time for the composite sheet 140, the sheet is drawn around a position roll 142 which increases the distance of travel around the curing drum 141. While an adhesive was not applied between the crosslaid webs in the illustrated case, it will be appreciated that the web fibers will be embedded sufficiently within the adhesive of the cover sheets as to form a firmly bonded composite material. After being cured, the composite sheet is drawn and wound around a take-up roll 144. Referring to FIG. 5, the finished composite material includes the outer cover sheet 128, fibers of the web 110 oriented longitudinally, crosslaid fibers of the webs 44, 45 shown laying on either side of a phantom line 145 although being understood that there may be some overlap as previously pointed out, and the outer cover sheet 135.

In view of the foregoing, it can be seen that the apparatus and method of the present invention provides an efficient and reliable means of handling and crosslaying light-weight web fibers in the production of a composite non-woven material. It will be apparent to those skilled in the art that many variations from the examples given may be employed without departing from the spirit of this invention. For example, slivers introduced into the draw frames 14 and 115 may include thermoplastic fibers which, when heated, bond together. Also other types of oriented webs, especially webs which are deficient in cross-direction strength, such as creped tissue, carded webs, spread tow, plastic films or split film networks, highly oriented in the direction of travel, may be substituted for the highly drafted web if desired.

I claim as my invention:

1. Apparatus for fabricating a nonwoven material having highly oriented crosslaid materials therein, means for separating into discrete lengths a fragile web of material having a principal strength component oriented substantially in the longitudinal direction of the material, a first moving carrier made of permeable material, means for placing lengths of said web on said first carrier spaced intervals with said web strength components oriented in the direction of travel, another moving carrier cross parallel to first carrier made of permeable material, said first carrier being operable to convey each said web length to the position where said carriers cross, means for transferring said lengths from said first carrier to said other carrier when each said web length reaches said position, said other moving carrier receiving and conveying said transferred web lengths with their strength components oriented transversely to the direction of travel, means for placing other lengths of said web on a second moving carrier at spaced intervals with said web strength components oriented in the direction of travel, another moving carrier cross parallel to said second carrier made of permeable material, said second carrier being operable to convey each said other web length to the position where said carriers cross, means for transferring said other web lengths from said second carrier to said other crossing carrier when each web length reaches said position, each transferring means including an air pressure unit which creates an air flow through said crossling permeable carriers when each web length reaches the position where said carriers cross, said air flow causing each web length to be removed from the carrier on which it is conveyed and be held against the other crossing carrier, said second other carrier receiving and conveying said transferred web lengths with their strength components oriented transversely to the direction of travel of said other carrier, and a continuous moving medium receiving said lengths of web from said other carriers with the web strength components oriented transversely to the direction of travel of said medium.
2. The apparatus of claim 1 in which said placing means includes a pair of juxtaposed screen rolls, said first carrier being movable about one of said screen rolls and said second carrier being movable about the other screen roll, said screen rolls forming a nip between said first and second carriers through which said web lengths pass, said screen rolls each having a suction pressure acting over a portion of their circumferences and said suction portions engage alternate lengths of said web and direct them along the respective carrier associated with that screen roll, and said moving medium receives said web lengths from said other carriers in alternate succession to form an uninterrupted ply of crosslaid webs on said medium.

3. The apparatus of claim 1 in which said separating means is a pair of juxtaposed screen rolls which form a nip through which said web is drawn, said screen rolls each having a suction pressure acting over half of their circumferences and being rotatable out of phase with each other so that said screen roll suction portions alternately engage said web and separate it into lengths corresponding to the circumferential length of the screen roll suction portion, and said first and second carriers each being operable about one of said screen rolls to receive said alternate web lengths.

4. The apparatus of claim 1 in which said separating means includes a rotatable knife roll and a juxtaposed rotatable anvil roll which form a nip, said web being drawn through said nip and being severed by said knife roll into equal lengths corresponding to the circumference of said knife roll.

5. The apparatus of claim 1 in which said web comprises substantially aligned multiple slivers of staple length fibers, said fibers being oriented in the longitudinal direction of the web and forming the principal strength component of said web, and said moving medium is a continuous web of fibers substantially aligned in the direction of travel, said continuous web successively receiving alternate web lengths from said other carriers to form an uninterrupted ply of crosslaid fibers over said continuous web.

6. The apparatus of claim 5 including a continuous moving sheet of cover material, means for applying an adhesive to said cover material and means for combining said adhesively coated cover sheet and said continuous web with crosslaid web lengths.