ABSTRACT OF THE DISCLOSURE

A method for bias crosslaying fiber webs is disclosed. The method includes the use of a pair of endless belts between which a fiber web is imprisoned as it is advanced toward a carrier sheet moving at right angles to the belts. Each belt has an end roller which defines a nip from which the fiber web is discharged and the end rollers are journaled in a support element mounted for reciprocation transversely over and across the moving carrier sheet to crosslay the fiber web thereon at a resulting bias angle. A second pair of belts may be provided parallel to the first pair to bias crosslay a second fiber web on the carrier sheet in substantially edge-to-edge relation to the first web. In the preferred embodiment additional webs of material may be deposited on the carrier sheet in longitudinal relation and bonded to the bias crosslayed components. The edges of the composite material may also be cut and stripped away.

BACKGROUND OF THE INVENTION

The present invention relates generally to nonwoven materials and more particularly concerns a method for bias crosslaying light-weight fiber webs.

In recent years nonwoven fabrics and materials have gained increasing acceptance for use in single and limited use disposable articles such as sheets and garments. Typically, these nonwoven fabrics employ several component layers one or more of which include fibers oriented to produce the requisite strength in the nonwoven material. For many uses, very low fiber weights may produce the requisite strength; provided, of course, that the fibers are substantially uniformly distributed in appropriate orientations. However, very lightweight fiber webs are difficult to handle and control in a uniform manner at acceptable production speeds when they are not deposited along the machine direction.

Accordingly, it is the primary aim of the present invention to provide an improved method for handling and controlling the deposit of light fiber webs at an angle to the machine direction.

It is a more particular object to provide positive control means for bias crosslaying light-weight fiber webs on a supporting carrier sheet. More specifically, it is an object to provide a pair of endless control belts between which a light-weight fiber web may be imprisoned and to reciprocate the end rolls for the respective belts such that the fiber web is discharged therebetween at a resulting bias angle on the moving carrier sheet.

A further object of the invention is to provide a method for bias crosslaying light-weight fiber webs and for bonding these webs together on to additional longitudinally oriented components to form a composite nonwoven material.

These and other objects of the invention will become more readily apparent upon reading the following detailed description and upon reference to the accompanying drawings.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Turning now to the drawings, there is shown in FIG. 1 a bias crosslaying apparatus embodying the features of the present invention. The apparatus 10 includes a supporting frame 11 on which end rollers 12 and 13 (see FIG. 2) are journaled to define a generally horizontal flow path over which a carrier sheet 14 moves in the direction of arrow 15 from a supply roll 16 to a take-up roll 17. Prior to passing over end roller 12, the carrier sheet 14 may have adhesive applied to its upper surface by a suitable adhesive applicator indicated generally as 18. Disposed at right angles to the movement of the carrier sheet 14 are a pair of web crosslaying mechanisms 20 and 21 supported by respective frame elements 22 and 23 extending upwardly from the main frame 11. At the outboard end of each of the crosslaying mechanisms 20, 21 there is a fiber web supply source, indicated generally at 24 and 25. The fiber web supply sources 24, 25 may be in the form of carding machines, drafting frames, air formers, spinnerets or any other apparatus for forming and supplying a light-weight fiber web 26 and 27. Alternatively, the webs 26, 27 may be supplied from rolls of previously formed light-weight fiber web material.

In accordance with the present invention, the fiber web 26 is continuously fed from its source 24 and imprisoned between a pair of endless control belts 30 and 31 in the crosslaying mechanism 26. As shown in FIGS. 3 and 4, each of the control belts has an end roller 32 and 33, respectively, journaled in a support element 34 mounted for reciprocation transversely over and across the flow path of the carrier sheet 14 on a pair of substantially horizontal rails 35 and 36. The end rollers 32 and 33 and respective belts 30 and 31 define a nip 37 therebetween from which the imprisoned fiber web is discharged to crosslay the web on the moving carrier sheet 14 at a resulting bias angle as the support element 34 is reciprocated back and forth across the carrier sheet 14. By imprisoning the web 26 between the control belts 30 and 31, the web is maintained under positive control. This makes it possible to bias crosslay the light-weight fiber web 26 at high speeds without subjecting the web to excessive windage.

In the illustrated embodiment the control belts 30, 31 define a pair of substantially nested, horizontally disposed U-shaped loops with the lower leg of each loop terminating at the discharge nip 37. Preferably, the belts 30, 31 are driven by rollers 38 and 39 which define the ends of the upper legs of the horizontally disposed U-shaped loops. The rollers 38, 39 are driven at the same speed but in opposite directions by suitable drive means such as, for example, a variable speed motor 40, drive chain 41, drive shaft 42 and a direction reversing chain 43. Between the respective discharge nip 37 and drive rollers 38, 39 the belts 30, 31 are guided by a series of intermediate rollers 45-49 which are journaled on a movable carrier frame 50 so as to define the base portion of the U-shaped loop of each belt 30, 31. As seen in
FIG. 4, the outer U-shaped reach of belt 31 is trained around rollers 45 and 46 and the inner U-shaped reach of this belt is disposed over rollers 47 and 48 in face-to-face relation with a nested U-shaped reach of belt 30. The innermost U-shaped reach of belt 30 is trained over roller 49. The carrier frame 50 is slidable mounted on the rails 35 and 36, which support the slide element 34, and on a pair of upper rails 38a and 38b, which are provided to help reduce binding.

To control the amount of tension applied to each of the belts 30, 31, the respective drive rollers 38 and 39 are preferably journaled in movable bearings 51 and 52 and means such as a spring 53 and adjusting bolt 54 are provided for adjustably biasing the bearings 51, 52 relative to the frame 22. Additional rollers 55-60 are also provided for suitably guiding and supporting the belts 30 and 31 as required.

Pursuant to the invention, means are provided for reciprocating the nip roller support element 34 and the intermediate roller carrier frame 50 to alternately increase and decrease the relative lengths of the legs of the horizontally disposed U-shaped belt loops. In the illustrated embodiment the reciprocating means includes an endless drive chain 62 disposed about a pair of sprockets 63 and 64 and an operating rod 65 connected at one end to the carrier frame 50 and at the other end to the drive chain 62. The sprockets are carried on shafts 66 and 67 journaled by bearings in a frame component 68. Preferably, shaft 66 carries another sprocket 69 driven by a variable speed motor 70 through a drive chain 71.

As best seen in FIG. 5, the operating rod 65 is coupled to the drive chain 62 by means of a special link plate 73 and post 74. The rod 65 is held in the post 74 by a flanged bushing 75 and a snap ring 76. The other end of the rod is similarly held by a flanged bushing 77 and snap ring 78 on a post 79 projecting from the carrier frame 50. The lengths of the posts 74 and 79 should be made as short as strength and clearance requirements permit in order to avoid excessive twisting movements on the operating rod 65.

Recurvating movement of the carrier frame 50 as the operating rod 65 orbits around the sprockets 63 and 64 on the drive chain 62 also causes reciprocation of the slide element 34. As the carrier frame 50 moves to the right on its guide rails the slide element is pulled to the right by virtue of the lower legs of the belt loops being trained over end rollers 32 and 33. Moreover, due to the inner and outer reaches of the belt loops, the slide element 34 moves two increments for each increment of movement of the carrier frame 50.

To move the slide element 34 to the left as seen in FIGS. 3 and 4, a cable 80 connected to the left side of the element is trained over pulleys 81 and 82 journaled on opposite ends of the frame 22 and then over a pulley 83 journaled on the carrier frame 50. The other end of the cable 80 is anchored to the frame preferably by an adjustable biasing spring 84, which with the springs 83 keeps the belts 20, 21 properly tensioned. As the carrier frame moves to the left one increment, the double reach of the cable 80 between the spring 84 and pulley 82 causes the slide element 34 to move two increments to the left.

From the foregoing it will be seen that moving the carrier frame 50 back and forth a distance equal to one-half the width of the carrier sheet 14 causes the slide element 34 to reciprocate across the full width of the carrier sheet. The initial spacing of the slide element, of course, is selected so that the nip of the end rollers 32 and 33 is adjacent one edge of the carrier sheet 14 when the carrier frame 50 is at one end of its stroke. In the preferred embodiment, the slide element 34 is also provided with a pair of discharge guide rollers 85 and 86 to control the web 26 as it is being deposited on the carrier sheet 14.

Although only one of the crosslaying mechanisms 20 has been described in detail it will be understood that the other crosslaying mechanism 21 is identical, except that it is driven from the opposite side from the common drive motors 40 and 70. It should also be understood that the carrier frames 50 of both crosslaying mechanisms 20, 21 may be driven by two operating rods 65 and drive chains 62, one on each side of each carrier in order to minimize the tendency of the carrier to bind on its rails.

In the preferred embodiment, the two crosslaying mechanisms 20, 21 are spaced apart such that the webs 26 and 27 are bias crosslaid on the carrier sheet 14 in substantially edge-to-edge relation. The exact relationship of the bias crosslaid webs to the carrier sheet, of course, depends on a number of parameters including: the speed and width of the carrier sheet; the speed and travel of the slide elements 34; and the spacing, width and discharge speeds of the webs 26 and 27. These relationships may be illustrated by the following example.

If it is desired to produce a 60" wide web of 60" bias crosslaid material at 100 ft./min., the webs 26 and 27 must issue from their respective discharge nips 37 at 200 ft./min. To lay the webs 26 and 27 straight at 60", the slide element 34 must move back and forth at a velocity of 173.2 ft./min. over the central 60" of the carrier sheet 14. Due to the doubling effect of the cable 80, the slide carriage 50 moves only half as far as the slide element 34 at constant velocity. This fixes the center to center spacing of the sprockets 63, 64 at 30". In other words the post 74 connecting the crank arm 65 to the chain moves from centerline to centerline, or from tangency to tangency, of the sprockets 63, 64 at a constant velocity of 86.6 ft./min.

As the connecting rod 65 is carried around each end sprocket 63, 64, the carrier frame 50 and slide element 34 decelerate to zero velocity, reverse directions, and accelerate up to their respective constant velocities of 86.6 ft./min. and 173.2 ft./min. This carries the webs 26 and 27 outboard of the central 60" of web material by an amount nearly equal to the pitch diameter of the sprockets 63, 64. Actually, the webs are carried outwardly slightly more than the pitch diameter of the sprockets on one side of the carrier sheet 14 and slightly less on the other side due to the angular relationship of the connecting rod 65 as it passes around the sprockets. It will also be understood that as the webs 26 and 27 move outwardly more than 30" from the centerline of the carrier sheet 14, the web angle changes from positive to negative much like a sine wave modified by the angular relationship of the crank arm.

To determine the widths of the webs 26 and 27 it is necessary to know how far the carrier sheet 14 travels during one complete revolution of the chain 62 around the sprockets 63 and 64. If the chain has 100 links and the sprockets each have 20 teeth, there will be 40 links in each reach of the chain tangent to the pitch of the sprockets and 10 chain links engaging the periphery of each sprocket. Thus, the carrier sheet 14 will move 1/4 as far during the period that the slide 34 decelerates, reverses and accelerates as it does while the carrier moves at constant velocity across the central 60" of the carrier sheet.

The latter, of course, is equal to 60"/√3=34.642" and the former is then equal to 34.642/4=8.66". Thus the carrier sheet travels 34.642"+4.66" or 43.3" during the complete reciprocation of the slide 34 and the width of each web 26 and 27 must be equal to this dimension to completely cover the carrier sheet 14.

Finally, to place the webs 26 and 27 in edge-to-edge relationship the crosslaying 20 and 21 should pull apart a distance equal to an odd numbered repeat interval times the web width, for example, 3×43.3" or 129.9 inches apart.

In the illustrated embodiment, the web material adjacent each edge of the crosslaid web is removed. It will be appreciated from the foregoing discussion that webs 26 and 27 are not laid at a constant angle adjacent the
edges of the composite web. In order to provide a composite web having uniform characteristics it is desirable to trim the edges of the web. For this purpose the apparatus 10 is provided with a pair of slitter wheels 88 and 89 which engage the back-up roll 13. The back-up roll in the present instance is driven by a motor 90 through a conventional chain drive 91 (see FIG. 2). The material trimmed from the web may be collected by any conventional means such as suction nozzles 92 and 93 schematically illustrated on either side of the apparatus 10. The nozzles 92 and 93 are connected to a suitable vacuum source and receiving receptacle, not shown.

The present invention also contemplates the addition of a top layer of elongated web material. As shown in phantom in FIG. 2, a top web 100 is drawn from a supply roll 101 and, after being printed with adhesive by a suitable applicator unit 102 is combined with the crosslaid webs 26 and 27 under roll 13. The web material 100 may be of the same material as the base web or carrier sheet 14 or it may be of some other material, as desired.

The present invention also provides means for bonding the composite web material together. For this purpose a pair of heated calender rolls 104 and 105 are journaled for rotation on the frame 11 downwardly of the slitter wheels 88 and 89. It will be understood that the calender rolls 104 and 105 may be heated by steam, oil or any other suitable source well known in the art. Following the bonding operation the composite web may be subsequently cooled by passing the web material over one or more cooling drums (not shown) prior to being wound on the take-up roll 17.

While the invention has been illustrated and described in connection with certain preferred embodiments and procedures it will be understood that it is not intended to limit the invention to the specific method and apparatus disclosed. On the contrary the invention is intended to encompass such alternative and equivalent embodiments and procedures as fall within the spirit and scope of the invention.

I claim as my invention:

1. A method of crosslaying a lightweight fiber web comprising the steps of:
   moving a carrier sheet along a generally horizontal flow path,
   imprisoning a fiber web between a pair of endless control belts disposed in nested, generally horizontally disposed U-shaped loops with the end rollers of the lower legs thereof defining a discharge nip, reciprocating the end rollers back and forth across the carrier sheet in a substantially horizontal path to discharge the imprisoned fiber web therefrom and crosslay the web on the moving carrier sheet at a resulting bias angle,
   and changing the relative lengths of the legs of the U-shaped belts to compensate for changes in the position of the discharge nip by simultaneously reciprocating a plurality of rollers which support and guide the respective bases of the nested U-shaped belts back and forth in a substantially horizontal path.

2. The method defined in claim 1 including the steps of:
   imprisoning a second fiber web between a second pair of endless control belts disposed in nested, generally horizontally disposed U-shaped loops with the end rollers of the lower legs thereof defining a second discharge nip located downstream along the flow path from the first nip,
   reciprocating the second pair of end rollers back and forth across the carrier sheet in a substantially horizontal path to discharge the second imprisoned fiber web therefrom and bias crosslay the second web on the moving carrier sheet in substantially side-by-side relation to the first fiber web,
   and changing the relative lengths of the legs of the second pair of U-shaped belts to compensate for changes in the position of the second discharge nip by simultaneously reciprocating a plurality of rollers which support and guide the respective bases of the second pair of nested U-shaped belts back and forth in a substantially horizontal path.

3. The method defined in claim 2 including the step of bonding the first and second bias crosslaid webs together.

4. The method defined in claim 2 including the step of cutting away the longitudinal edges of the bias crosslaid material.

5. The method defined in claim 1 including the step of adding at least one additional web of material on the carrier sheet with the additional web disposed substantially parallel to the flow path.

6. The method defined in claim 2 wherein one additional web of material is longitudinally laid on the carrier sheet in advance of the bias crosslaid webs and another web of material is longitudinally laid on the carrier sheet over the bias crosslaid webs.

7. The method defined in claim 6 including the step of bonding the longitudinal and bias crosslaid webs together.

8. The method defined in claim 7 including the step of cutting away the longitudinal edges of the bonded material.

References Cited

UNITED STATES PATENTS
2,434,887 1/1948 Repass et al. --------- 156—440 X
2,566,922 9/1951 Brown et al. ---------------- 156—440 X
3,041,230 6/1962 Diehl --------------------- 156—172
3,236,711 2/1966 Adler --------------------- 156—175 X
3,345,230 10/1967 McLean ------------------ 156—439 X
2,710,992 6/1955 Goldmann ------------------
2,933,774 4/1960 Adams, Jr. -------------- 156—440 X

FOREIGN PATENTS
1,359,560 7/1963 France ------------------ 156—166

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