A web composed of long and short fibers can be produced on this machine. Two separate air ducts convey the two types of fibers to two rotating condensers on which the respective fibers are laid down forming fiber mats. The fibers are combed from the two mats by two rotating lickerins and are doffed from the lickerins by two separate air streams flowing past the lickerins and by the centrifugal forces created by the high speed rotation of the lickerins. They are carried by the air streams into a mixing and expansion chamber in which the fibers blend and intermingle. Pivotal vanes disposed above or in the air streams and a divider plate adjustable into the mixing and expansion chamber control the direction and flow of the air streams to control the positions and relative amounts of the long and short fibers in the random fiber web formed in the machine.
MACHINE FOR FORMING RANDOM FIBER WEBS

The present invention relates to a method and apparatus for producing non-woven textile articles, that is, textile articles produced without spinning, weaving or knitting operations. In a more specific aspect, the invention relates to organized machines of the general type disclosed in the Langdon U.S. Pat. No. 3,512,218, issued May 19, 1970 and in the Wood U.S. Pat. No. 3,535,187, issued Oct. 20, 1970.

With the machines of the prior patents mentioned difficulties have been experienced in getting a uniform blend of fibers of different lengths in a random fiber web. Another disadvantage encountered sometimes with these prior machines is that of securing desired ratios and desired varieties of fiber distribution in a web.

One object of the present invention is to provide a machine capable of forming random fiber webs from a blend of long and short fibers. The long fibers may be of natural or synthetic origin and of textile length. The short fibers may be paper making fibers, such as produced from wood pulp, or cotton linters, or the like.

Another object of the invention is to provide a machine of the character described in which the proportion of short fibers to long fibers may readily be adjusted as required by the type of random fiber web which it is desired to produce.

Another object of the invention is to provide a machine of the character described which can produce selectively webs that have different fiber distributions, for instance, webs that have outer layers made up each of two different fibers and an intermediate layer that is a homogeneous blend of the two fibers, or webs in which the fibers of one type predominate at one side of the web and fibers of another type predominate at the other face of the web and where the two different types of fibers intermingle at the center of the web, or a web made of two separate layers of different fibers that are only intermingled at the region of their interface.

Another object of the invention is to provide a machine of the character described which will produce a random fiber web having substantially uniform strength lengthwise and crosswise and depthwise thereof.

Another object of the invention is to provide a machine of the character described which will operate more efficiently and at higher speed than machines of this type previously constructed.

Still another object of the invention is to provide a machine which will produce improved, non-woven webs. To this end, a further object of the invention is to provide a machine of the character described which will eliminate the formation of objectionable lumps of fibers in the finished non-woven web.

A still further object of the invention is to provide a machine which will produce non-woven webs stronger than present such webs.

Other objects of the invention will be apparent hereinafter from the specification and from the recital of the appended claims, particularly when read in conjunction with the accompanying drawings.

In the drawings:
FIG. 1 is a somewhat diagrammatic, fragmentary sectional view in a vertical plane through web forming apparatus made according to one embodiment of this invention;
FIG. 2 is a similar view showing a modification of the machine; and
FIG. 3 is a similar view illustrating fragmentarily a still further embodiment of the invention.

The machine of this application is quite similar generally to the machine of the Langdon U.S. Pat. No. 3,512,218. Air-borne fibers of different characteristics, respectively, may be delivered to the machine through chutes 10 and 12, which in turn deliver them into trumpets 14 and 16, which form parts of air bridge systems that convey the fibers from the chutes 10, 12 to rotary feed condensers 18 and 20.

The condensers may be of conventional construction and comprise rotary screens 22, 24 which revolve about fixed suction tubes 26, 28, respectively. The outer walls of the trumpets converge around the condensers toward the periphery of the condensers so as gradually to compress the fiber mats formed on the condensers by the fibers deposited thereon. Doffing rolls 30 and 32, respectively, which are disposed in contiguity to the condenser screens, doff the fiber mats, which are laid down on the condenser screens onto feed plates 34 and 36, respectively. These feed plates are extensions of the plates that bound one side of each of the trumpets 14 and 16.

The mats are picked up by feed rolls 38 and 40, which feed the mats over the nose bars 42, 44 that are secured to the feed plates. The feed rolls feed these mats into the rotating lickerins 46 and 48, respectively. The lickerins are of standard construction as are the feed plates and feed rolls.

The lickerins have peripheral teeth which comb fibers from the mats as the mats are fed into the lickerins and as the lickerins revolve. The lickerins are driven at high speed according to conventional practice; and the fibers are doffed from the teeth of the lickerins by centrifugal force and by air streams flowing over the teeth of the lickerins.

The air streams for doffing the fibers from the lickerins are supplied through an air inlet tube 50 which may be fed by a pressure fan or fans. A restrictive slot 52 in this duct 50 equalizes the widthwise flow into the plenum or air chamber 54 through which the duct 50 extends. This plenum may be of generally rectangular cross section, as illustrated in U.S. Pat. No. 3,512,218, and has ports in its bottom through which the air flows into a common air balancing chamber 56.

Mounted in this chamber 56 are two pivoted deflectors 58, 60 which are disposed at opposite sides, respectively, of an intermediate fixed deflector 62.

The opposite sides of this balancing chamber 56 are bounded by the feed plates 34, 36, which in their upper portions have downwardly generally converging surfaces 61, 63 and in their lower portions have downwardly converging sidewalks 64, 66.

Mounted within the air chamber 56 is an air divider 68, which is of generally triangular shape in cross section with its apex at its top. Journaled on eccentric bushings in the bottom of the divider at opposite sides thereof, respectively, are rotary sabers 70 and 72; and reciprocally mounted within the divider to be adjustable vertically between the two sabers is a plate 74, which like the divider 68, extends across the full width of the chamber 56. Adjustment of this plate is effected by rotation of a pinion 76 which engages a rack 78 formed on the plate. Two different positions of the plate are shown in full and in dotted lines, respectively, in FIG. 1.
Air flow from chamber 56 past the lickerins serves, in combination with the centrifugal force produced by the high speed rotation of the lickerins, to doff the fibers from the lickerins, and carry the fibers downward into an aerodynamic fiber mixing and expansion chamber 80.

The air flowing through the air balancing chamber 56 splits at the apex of divider 68, passes through the passageways between the lickerins and the sides of the divider 68, and serves in conjunction with the centrifugal force produced by the high speed rotation of the lickerins, to doff the fibers from the lickerins. The air velocity is a maximum normal to the lickerins. Doffing blades 77, 79 juxtaposed to the lickerins aid in the doffing action by preventing fibers being carried around the lickerins in the bound layers of air.

The doffed fibers are carried by the two air streams into the fiber mixing and expansion chamber 80 and are deposited on an endless screen condenser 82, that may be made on Fourdriner screening and that travels across the mouth of chamber 80 over two rolls 84 and 86, which are mounted on two rotary shafts 88 and 90, respectively. The roll 86 may be driven from a motor 92 through pulleys 94 and 96, respectively, and the belt 98.

Mounted within the screen 82 is a negative air pressure chamber or suction box 100, which is connected by air ducts 102 and 104 to air ducts 106 and 108 which deliver the air to suction fans (not shown) that in turn deliver the air to opposite ends of the air inlet tube 50. The construction is similar to that shown in U.S. Pat. No. 3,521,218.

The adjustable, eccentrically-mounted rolls 70 and 72 regulate the velocity of the air via a venturi section at each side of the chamber 56 and are adjustable independently of each other selectively to throttle the air and fibers passing out of the lower ends of the passageways formed on opposite sides of divider 68. Hence the flow and velocity of air is adjustable to the necessary proportions called for by the different types and quantity of fibers being processed through the machine. Two dissimilar fibers, such as pulp and textile length fibers, require different flow characteristics as these fibers are projected into the expansion and mixing chamber. They can readily be handled, therefore, with the adjustments provided for the sabers.

The nose bar-feed plate assembly must fit tight to the curvature of the lickerins to hold the fibers within the boundary layers of the lickerins. The fibers must not be allowed to expand after they have been combed out of the feed mats at the nose bars. Expansion of the fiber flow should only be allowed at the junction of the air from the inlet air chamber 54 via the venturi formed between the sides of the divider 68 and the confronting surfaces of the feed plates 34, 36. This has a very marked effect on the quality of the non-woven web.

In the machine described, the sabers 70, 72 have their axes lying in the same plane as the axes of the lickerins 46, 48. This allows the center baffle 74 to be withdrawn into the air divider chamber, or lowered in that chamber, to provide the required interface mixing of the two fiber inputs at the final web construction. The common inlet air flow is divided by the wedge shaped divider, and may also be deflected by the adjustable air vanes above the divider. Thus more or less air may be directed toward either side of the inlet chamber, so that more air may flow to one side or the other as dictated by the type of fibers being processed. This arrangement permits exact control of the fiber and air flow paths, thus allowing, where preferred, maximum interface mixing and graduated layer control in the final web construction of two dissimilar fibers, such as pulp and textile length fibers, which have different flow characteristics.

By pivotal adjustment of the vanes and of the vertical position of the divider plate, substantially complete control over the character of the random fiber web formed in the machine can be obtained. A web can be formed in which the bottom layer consists substantially of all short fibers, the upper layer contains substantially all long fibers, and an intermediate layer is formed in which the short and long fibers blend; and the thickness of this intermediate layer can be varied, or reduced substantially to zero.

As in U.S. Pat. No 3,512,218, the mixing and expansion chamber 80 is bounded by side walls 110 and 112. The side wall 110 may be relatively fixed, but the side wall 112 is made in two parts hingedly connected to one another. It pivots at one end about the axis of roll 116; and it pivots intermediate its ends on the hinge 118. It is adjustable by adjustment of its lower part 120 to control the thickness or weight of the web being formed. Adjustment of the lower section 120 may be effected by adjustment of a screw (not shown), which is manipulated by a knob 124, and which threads into the lower part 122 of the frame of the machine, and is carried by a link 126 that is connected by the plate 128 to the lower section 120 of the side wall.

The embodiment of the invention shown in FIG. 2 is similar to that of FIG. 1, and like parts in this figure are denoted by the same reference numerals as employed in FIG. 1.

In this embodiment, the air divider 168 extends upwardly to the plenum chamber 154 which receives the air from the duct 50. The central air vane 62 is eliminated; and the adjustable pivotal vanes 58 and 60 are positioned in the passages formed at opposite sides of the divider 168. Also, the adjustable sabers 70 and 72 here operate as velocity control devices at the inlet jet point of the input air to the mixing and expansion chamber 80. Otherwise, the operation is the same as described with reference to the first embodiment of the invention.

FIG. 3 of the attached drawings shows fragmentarily a somewhat different embodiment of the invention. In this figure, parts similar to those already described are designated by the same reference numerals as employed in FIGS. 1 and 2.

Here the divider, which is designated as a whole at 200, has flexible side walls 202 and 204 which are coupled at their upper ends 205, as by a spring and extend over a roller 206. These side walls are adjustable toward and away from the lickerins 46, 48 to control the width of the passages 210 and 212 between the lickerins 46 and 48 and the divider. Adjustment of the side walls 202, 204 is effected by rotation of the rollers 214 and 216, respectively, which are mounted eccentrically on shafts 218 and 220, respectively.

A coil spring 222, which is secured at opposite ends in loops 224 and 222, respectively, that are welded to the sidewalls 202 and 204, respectively, holds the side walls against the rollers 214, 216. The spring passes under a roller 228.
The side walls 202 and 204 at their lower ends engage straps 230 and 232, respectively, which are secured by plates 234 and 236 and screws 238 and 240, respectively, to side plates 242 and 244, respectively, which, in turn, are fastened by screws or rivets 246 and 248, respectively, to the plates 250 and 252, respectively, that serve as guides for a centering member 254, which is adjustable vertically in the divider. For the purposes of this adjustment, the unit 254 is fastened to a block 256 which is secured to a screw shaft 258 that is journaled in a bridge member 260, which is welded at opposite ends to the plates 242 and 244. The shaft is journaled in a suitable bushing 262 fastened on the upper side of the bridge member 260. Adjustment of the shaft may be effected by gears or chains, which mesh with gears or sprockets 274 and 276, that are keyed to the shaft 258.

In this embodiment, doffing of the fibers from the lickerin is achieved by the doffing plates 247 and 276, respectively, which are fastened to plates 278 and 280, respectively, by screws 282 and 284, respectively. Wipers 286 and 288, respectively, are fastened to these plates 278 and 280, respectively, by screws 290 and 292, respectively. The wipers engage the rollers 294 and 296, respectively, on which the side plates 298 and 300, respectively, are mounted. These side plates bound the outside of the passages 302 and 305 through which the respective fibers flow to the mixing chamber.

The side wall 298 can be adjusted by manipulating the handle 306. A seal 308, which is fastened to the side plate 298, and which is positioned to engage the upper reach of the condenser screen 82, serves to seal against the passage of fibers out of the machine.

Side plate 300 may be made in two parts, as are the side plates 112 previously described. The lower section of side plate 300 may be pivoted at 310 on its upper section, and this lower section may be adjusted by a link 126, which is secured to the plate 128 similar to that previously described. A screw operated by a knob 124 and threading into the frame section 122 of the machine is provided for effecting this adjustment.

Cover plates 314 and 316 are provided adjacent the lickerins 46 and 48, respectively, to prevent the air layer around the lickerins from carrying fibers around them.

With the construction shown in FIG. 3, the nose 254 of the center divider 200 may be lifted or lowered to allow for intermixing of the fibers at the interface of the two web structures developed at either side of the center. Hence, we are able to adjust the amount of gradation between the fibers on the lower face to those of the upper face of the non-woven web formed on the machine. Thus, the machine may be employed to simultaneously process into a single web two different kinds of fibers, for instance, polyester fiber on one face and bleached pulp fiber on the other face.

In all embodiments of the invention, the air inlet supply chamber uses a common inlet, and is principally a closed circuit connected with suction chamber below the condensing screen. Atmospheric air may “bleed” into the system via ports situated on the suction side of the fans and downstream from the suction chamber. Thus we may allow the fans to work at the designated static pressure and flow conditions so as to provide the necessary positive and negative pressure flow within the machine.

While the invention has been described in connection with several different embodiments thereof, it will be understood that it is capable of further modification, and this application is intended to cover any modifications of the invention that come within its scope or the limits of the appended claims.

Having thus described my invention, what I claim is:

1. A machine for forming random fiber webs comprising:
   a frame,
   two separate, laterally-spaced foraminous condensers rotatably journaled in said frame,
   separate conduits for conveying fibers suspended in air to said condensers to form fiber mats on the two condensers
   means for doffing the mats from the two condensers,
   two rotary lickerins rotatably journaled in said frame,
   means for feeding the mats into the lickerins so that the lickerins in their rotation comb fibers from the two mats, respectively,
   a plenum,
   means for supplying air under pressure into said plenum,
   an air balancing chamber,
   means for directing an air stream from said plenum into said balancing chamber,
   a divider dividing said balancing chamber into two separate passageways through which the air from said plenum flows past the two lickerins, respectively,
   to doff, in conjunction with the high speed rotation of the lickerins, fibers from the lickerins,
   separate means adjacent the lower end of said divider and associated therewith for separately adjusting independently of one another the depths of each of the two passageways, respectively, thereby selectively to throttle the flow of air and fibers through said passageways,
   a common mixing and expansion chamber disposed beneath said passageways in communication therewith and into which the fibers doffed from the lickerins are carried by the two airstreams in the two passageways,
   said mixing and expansion chamber being open at its lower end,
   a foraminous condenser movable across the open lower end of said mixing and expansion chamber, and
   suction means disposed in operative relation to the last-named condenser to cause fibers to be drawn from said mixing and expansion chamber and deposited on said last-named condenser to form a random fiber web thereon.

2. A machine as claimed in claim 1 wherein said divider is wedge-shaped and has laterally adjustable, downwardly diverging sides which bound, respectively, one side of each of said passageways.

3. A machine as claimed in claim 2, wherein a plate is mounted in said divider, and means is provided for moving said plate into and out of said mixing and expansion chamber and to variable depths therein, to control the point where the air streams carrying fibers into said mixing and expansion chamber blend.

4. A machine as claimed in claim 3, wherein vanes are disposed above said divider and are pivotally mounted in said balancing chamber for pivotal adjustment to control the direction and velocity of flow of the air stream in said balancing chamber.
5. A machine as claimed in claim 4, wherein the vanes are disposed in said passageways.

6. A machine for forming random fiber webs comprising
   a frame,
   two separate, laterally-spaced foraminate condensers rotatably journaled in said frame,
   separate conduits for conveying fiber suspended in air to said condensers to form fiber mats on the two condensers,
   means for doffing the mats from the two condensers,
   two rotary lickerins rotatably journaled in said frame,
   means for feeding each of the mats into a different one of said lickerins so that each lickerin in its rotation combs fibers from one of the two mats, respectively,
   a first chamber,
   means for directing an air stream into said first chamber,
   means dividing said chamber into two separate passageways through which the air in said chamber flows past the two lickerins, respectively, to doff, in conjunction with the high speed rotation of the lickerins, fibers from the lickerins,
   a mixing and expansion chamber disposed beneath said passageways in communication therewith and into which the fibers doffed from the lickerins are carried by the airstreams,

7. A machine as claimed in claim 6, wherein side walls are movable toward and away from one another, and the means for varying the angular positions of said side walls comprise rollers disposed in engagement with said side walls, each of said rollers being mounted for rotation about an eccentric axis whereby upon rotation of a roller the position of the associated side wall is adjusted to vary the depth of the associated passageway.

8. A machine as claimed in claim 7, wherein the axes about which the rollers are eccentrically adjustable lie in the same plane as the axes of the two lickerins.

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