A. M. Smith II

Method of Needle Punching Fibers to Make Needled Fabrics or the Like

Filed May 26, 1960

Fig. 9

Fig. 10

Fig. 11

Fig. 12

Fig. 13

Fig. 14

Inventor:

Alexander M. Smith, II

By:

Lushman, Darby & Lushman

Attorneys
METHOD OF NEEDLE PUNCHING FIBERS TO MAKE NEEDLED FABRICS OR THE LIKE

Alexander M. Smith, II, Elkin, N.C., assignor to Chatham Manufacturing Company, Elkin, N.C., a corporation of North Carolina

Filed May 26, 1960, Ser. No. 31,910
13 Claims. (Cl. 28—72.5)

The present invention relates to an improved method for making a new and improved needleled or non-woven fabric material and to an improved apparatus for accomplishing the method. More particularly, the present invention contemplates an improved method of making a new and improved needleled or non-woven fabric material by providing subsurface interlooping of the fibers and/or some interlacing of the fibers, the invention also contemplating the use of an improved needle punching machine which provides needleled or non-woven fabric having both the web from opposite surfaces by utilizing needles adapted to penetrate the web at an acute angle to the direction of web travel.

Non-woven fabric structures, such as felt or felt-like products, derive their cohesion and strength from interfiber entanglement and accompanying frictional forces. Heretofore, felts have been formed by interlacing fibers, e.g., wood and wool-like fibers, by various mechanical working processes involving ruffling, squeezing, rolling under appropriate conditions of humidity and temperature. The advent of synthetic fibers in recent years has resulted in increased use of a needle punching process as such synthetic fibers do not have a structure which promotes felting by the above-mentioned mechanical processes.

The present invention contemplates utilizing a method and apparatus for needle punching a web or batt of loosely matted fibers to produce a non-woven fabric having a more positive interfiber or chain entanglement, the resulting new and improved needleled or non-woven fabric being adapted to have both surfaces uniform in appearance and structure. Further, the resulting new and improved needleled or non-woven fabric of the present invention may be napped evenly on both sides and yet have better tensile and separation strength after napping than non-woven fabrics heretofore produced. Because of softness with strength, the new and improved needleled or non-woven fabric produced by the present invention is especially adapted for use in making blankets of substantial thickness as well as outerwear fabrics or the like. The utility of the method and machine of the present invention is further increased as the new and improved needleled or non-woven fabrics may be made from either natural or synthetic fibers, or a blend of natural and synthetic fibers. Two or more webs of loosely matted fibers having a scrim of woven, non-woven or bonded fabric interposed between may be needle punched by the method and machine of the present invention, the resulting needleled or non-woven fabric having the desired tensile and separation strength as well as uniform appearance and structure on its surfaces.

Throughout the specification wherever the term “interlooping” is used, it defines a subsurface binding together of fibers in a web or the like of loosely matted fibers, the binding being accomplished by passing fibers through the loops of other fibers previously oriented below the surface of the web. Interlooping of fibers is akin to knitting as it provides entanglement of fibers by loop engagement rather than a binding by a tying action. On the other hand, the term “interlacing” as used throughout the specification is intended to define a binding together of fibers primarily from one outside surface of a web to the other outside surface of a web. Interlacing of fibers is somewhat similar to a sewing action although it does not depend on a continuous threaded action. In interlacing, the ends of fibers lying on one surface are carried through the web body and then returned to the initial side by another path so as to become oriented in a manner analogous to a thread in sewing as distinguished from interlooping where the binding is confined to subsurface fibers.

An important object of the present invention is to provide a new and improved needleled or non-woven fabric structure from an improved method of needling or punching a web or batt of loosely matted fibers which will result in producing a fabric structure obtaining its coherence and strength primarily from a substantially uniform interlooping of fibers, the resulting fabric structure having more tensile and separation strength, density and yet a softness of outer surfaces which makes it highly desirable for use in blankets, outerwear fabrics or other similar products.

Ancillary to the preceding object, it is a further object of the present invention to provide an improved type of needle punching apparatus for accomplishing interlooping and/or interlacing of fibers of a loosely matted fiber web or batt.

A further object of the present invention is to provide an improved apparatus which will compress a web and tightly interloop and/or interface loosely matted fibers upon one pass through the apparatus, the resulting product having extremely high tensile and separation strength.

Still another object of the present invention is to provide an improved method of needling loosely matted fibers to produce a needleled or non-woven fabric obtaining its strength from interlooping of fibers, the method contemplating needling the web from both sides to obtain a uniform finish on both sides of the resulting product. This is an important consideration when the product is subjected to subsequent finishing operations, particularly napping.

Ancillary to the preceding object, it is a further object of the present invention to provide an apparatus for interlooping fibers in a loosely matted fiber web or batt, the apparatus permitting fewer punches per lineal inch with a more definite interlooping pattern.

A further object of the present invention is to provide a method and apparatus for needling loosely matted fibers in a web, the method and apparatus providing less drag upon the web so that a needleled or non-woven fabric can be produced faster and with greater strength and more uniform characteristics.

These and other objects and advantages of the present invention will appear more fully in the following detailed specification, claims and drawings in which:

FIGURE 1 is a side elevational view of an improved apparatus for accomplishing the improved novel method of producing the new and improved needleled or non-woven fabric material of the present invention;

FIGURE 2 is an end elevation looking from the right of FIGURE 1, parts being omitted for the purpose of clarity;

FIGURE 3 is an enlarged vertical sectional view, partly in elevation, and taken on the line 3—3 of FIGURE 2;

FIGURE 4 is an enlarged fragmentary view of a web guide plate taken on the line 4—4 of FIGURE 3;

FIGURE 5 is a view taken on the line 5—5 of FIGURE 4;

FIGURES 6 and 7 illustrate progressive steps of interlooping fibers in chain entanglement as the web of material passes through the apparatus from the left to the right, the figures showing an opposed pair of cooperating upper and lower needles;

FIGURE 8 is a schematic view showing the paths of
the pair of cooperating needles in FIGURES 6 and 7 superposed upon one another;

FIGURES 9 through 11 schematically show the penetration pattern of a pair of opposed needles through a web moving from the left to the right in intermittent step-by-step increments;

FIGURES 12, 13 and 14 schematically show the interlooping of fibers in chain entanglement as provided by the movement of the needles shown in FIGURES 9 to 11, respectively.

Referring now to the drawings wherein like character and reference numerals represent like or similar parts, and in particular to FIGURE 1, a web or batt of loosely matted fibers generally designated at 10 is illustrated moving from the left to the right of the figure through a needle punch machine generally designated as 12. Passing from the machine 12 at the right hand side of the figure is a needle or non-woven fabric material shown in broken lines and generally designated by the numeral 14. It will be understood that the web or batt of fibrous material may be continuously fed from a conventional-carding machine where the fibers are carded and loosely formed into the web or it may be supplied from rolls of such material after the material has been taken from such carding machine and formed into a roll. If desirable, and depending upon the type of end product to be made, the web 10 in FIGURE 1 may be formed from two or more layers of loosely matted fibers such as 16 and 18 (FIGURE 6), the layers being separated by a scrim which is usually loosely woven fabric 20.

After the needle or non-woven fabric structure 14 is produced by the apparatus 12, it will be understood that subsequent treatment of the fabric may occur. In instances where the fabric 14 is to be used for blankets or the like, each of the surfaces of the fabric can be napped by conventional napping processes. By the unique interlooping of fibers accomplished by the present method and apparatus, the produced fabric 14 has a high pull apart or separation strength and it retains a majority of this separation strength even after napping.

While the present invention primarily results in interlooping fibers, it also results in some interlacing of fibers. By suitable changes in the method and adjustments in the operation of the machine, more or less interlacing of fibers can be obtained. A more detailed discussion of interlacing appears in my copending application entitled “Needle Punch Machine and Method,” Serial Number 29,115 and filed May 13, 1930, and it will be understood that such disclosure is incorporated by reference in this application.

In order to accomplish the novel method of the present invention resulting primarily in interlooping of fibers in the web 10 as well as some interlacing of fibers, the web is advanced through the machine in intermittent step-by-step motion between opposed patterns of needles 22 and 24. The needle patterns 22 and 24 are each arranged to move on a path of penetration at an acute angle to and in a direction opposite to the direction of travel of the web 10. While the needle patterns 22 and 24 swing in an arc as will be explained in more detail later in the specification, the radius of the arc is sufficiently great that the needles for all practical purposes travel substantially in a straight line when penetrating into or withdrawing from the web. In the preferred form of the invention, the center rows of needles of each pattern are made tangent to their arc when the needles are in a position of complete penetration within the web 10. When arranged as described, the needles travel in a path at an acute angle to the web travel and their path of travel is substantially parallel to the longitudinal axes of the needle shafts.

An alternative arrangement is to position the center row of needles of the patterns 22 and 24 at a slight angle to the tangent of their arc when the needles are in a position of complete penetration in the web 10. When arranged in this latter manner, the path of travel of the needles is at an acute angle to web travel but such a path is also at a slight angle to the longitudinal axes of the needles.

While the needle patterns 22 and 24 are shown penetrating at an acute angle to and in a direction opposite to the direction of web travel for purposes of description, it will be understood that the path of travel of the needles could be at an acute angle to and in the same direction as the direction of web travel.

Needle patterns 22 and 24 include needle boards 26 and 28 respectively. An array of needles 30 is carried by the needle board 26 whereas another array of needles 32 which oppose the needles 30 is carried by the needle board 28. Needles 30 are arranged on needle board 26 in a pattern which is a mirror image of the pattern of needles 32 arranged on the needle board 28. As heretofore mentioned, the needles 30 and 32 enter the web at an acute angle to the direction of feed of the web and since the two needle patterns 22 and 24 are mirror images of one another and operate in cooperation with one another, the paths of a pair of needles 30 and 32 will cross in a median plane of the web 10. A schematic representation of the paths of needles 30 and 32 is shown in FIGURE 8 and while the paths are shown as crossing, it will be understood that the paths are superposed one upon the other as an opposed pair of needles never enter the web simultaneously and instead, one needle moves in between successive penetrations of opposed needles.

A confined throat 34 defined by a pair of spaced apart web guide plates 36 and 38 provides a path for the web 10 to travel as the needle patterns 22 and 24 alternately punch or needle opposite surfaces of the web, the web 10 being moved a small increment in between successive penetrations of the patterns. Guide plates 36 and 38 are provided with curved inlet portions 40 and 42 which define a gradually decreasing inlet portion 44 for the throat 34. The inclined portion 44 guides the web 10 as it is compressed to a desired thickness as defined by the distance between the two guide plates 36 and 38.

Each of the guide plates 36 and 38 is provided with a plurality of holes 46, the holes 46 being arranged to receive the needles 30 and 32 of patterns 22 and 24 respectively. As shown in FIGURES 6 and 7, the needles which enter the web at an angle thereto pass through a pair of holes or slots 46 in the plates 36 and 38 respectively. The holes or slots 46 are elongated in the direction of travel of the web. The array of needles 30 and 32 are substantially identical in construction and include barbs 48 arranged along the surfaces of the same, the barbs being adapted to engage and orient fibers of the web 10 as the needles are moving on their penetrating stroke, but not engaging the fibers on the withdrawal stroke.

Referring now to FIGURES 6 through 8 inclusive as well as to the schematic FIGURES 9 through 14 inclusive, the letter T represents the direction of travel of the web 10 through the confined throat 34. As mentioned above, the motion of the web through the throat is in step-by-step increments with penetration of the web by the patterns of needles 22 and 24 occurring when the web is stationary. In FIGURE 6, the needle 30 of the upper pattern of needles 22 is shown penetrating the web and carrying with it subjacent fibers as well as some surface fibers of the same. FIGURE 6 illustrates the orienting of fibers from the upper surface of the web to a position wherein some of the looped ends of the fibers are positioned immediately below the surface opposite the needle. The surface of penetration is the certain amount of the fibers being oriented will pass through a small amount of the surface of penetration. FIGURE 12 schematically shows the loops of fibers oriented by the penetration of the needle 30 in FIGURE 6. In FIGURE 7, the needle 32 which is the mirror image of needle 30 is shown penetrating the web from beneath and carrying...
with it some surface fibers and some subsurface fibers of the lower surface of the web. It will be understood that prior to the penetration by the needle 32, needle 30 will have been completely withdrawn from the web and the web will have been moved in the direction of the arrow T to a small increment.

When the needle 32 enters the web as shown in FIGURE 7, its point of penetration is so placed on the surface of the web as well as subsurface fibers are carried through the loops of fibers previously oriented by the needle 30. This is shown schematically in FIGURE 13 wherein the fibers are passing upwardly to the left of the figure, through the subsurface loops of the fibers previously oriented by the needle 30. Also shown in FIGURE 13 is the position of fibers oriented by the needle 32. After needle 32 is withdrawn from the web, the web 10 is again advanced a small increment. Needle 30 begins its penetration after the web has stopped and as shown in FIGURE 14, fibers being oriented by the needle 30 are threaded through loops of fibers previously oriented by the needle 32. The alternate penetration of the oppositely disposed needles 30 and 32 continues as the web is moved in step-by-step motion through the confined throat 34.

FIGURE 8 illustrates the paths of penetration of opposed mirror image needles 30 and 32 superposed upon one another. Each pair of opposed needles 30 and 32 is arranged to penetrate through the web and intersect in a median plane represented by the broken line M of the web 10. It will be understood that the web 10 moves a small increment between successive penetrations of a pair of opposed needles 30 and 32, the increment being such that the initial penetration of the needles will be forward of the position where the opposed needle extended out of the web so that loops previously oriented by the other needle may be threaded. A schematic illustration of the movement of the needles through the median plane M relative to the movement of the web is shown in FIGURES 9 to 11 inclusive. In FIGURE 9, the stationary web is penetrated by the needle 30, the needle passing through the median plane of the web at a point designated A. As shown in FIGURE 10, the needle 30 has been withdrawn from the web, the web having been advanced a small increment and then the needle 32 has penetrated the web. In the position shown, the needle 32 intersects the median plane M of the web at B and the distance between A and B represents the increment of advancement. FIGURE 11 is a further sequential operation showing the needle 32 having been withdrawn, the web advanced a small increment and then the needle 32 again penetrating the web and intersecting the median plane at C. FIGURES 12, 13 and 14 show the sequence of interlooping of fibers to cause a chain entanglement of fibers in a row as represented by the movement of needles as shown in FIGURES 9 to 11, respectively.

While FIGURES 12 to 14 do not show surface fibers penetrating completely through the web, it will be understood that some fibers will be carried through the web as disclosed in my aforementioned application and there will be some interlacing of fibers so as to have a surface-to-surface bonding of the web as well as a subsurface-to-subsurface bonding of the web by interlooping.

Reverting now to FIGURE 4, the needle pattern 22 of needles 30 is illustrated, it being understood that the pattern of needles 32 is an identical mirror image of the pattern 22. Needles 30 are arranged in a plurality of rows extending transverse of the direction of travel of web 10. The rows of needles are staggered so that more needles may be punching the web transversely of the same in each widthwise inch. In other words, because the size of the needles will not permit the needles to be placed in close enough spaced relationship widthwise of the web, the rows of needles are staggered so as to provide a high number of needles punching the web for each widthwise inch of the web.

To accomplish effective interlooping by the above described method, it has been found that each needle pattern 22 and 24 must have an array or needles which will provide a range of needle punches per widthwise inch of the web 10 of about 25 punches to about 75 punches. Thus, in effect, there will be 25 to 75 paths of punches per widthwise inch as the web is advancing between the needle patterns 22 and 24. With the above range of widthwise punches, it has been found that each pair of opposed needles 30 would penetrate the web 10 in a range of 6 to 20 penetrations per linear inch of the web to obtain effective interlooping of fibers. On the other hand, effective interlacing as well as interlooping of fibers can be obtained within a range of 4 to 20 penetrations per linear inch. A preferable range of punches per linear inch is 7 to 14 penetrations for each needle of each pair of needles. The number of penetrations per linear inch is accomplished by moving the web in step-by-step increments for each successive penetration of a needle pattern, the increment of movement being determined by the range desired.

Barbed penetration, which in its distance of penetration through the web of the barb closest to the point of the needle, has been accomplished in a range of from the surface of the web opposite the surface of penetration to a point where the aforesaid barb extends one-half of an inch from the surface. A range of barbed penetrations with maximum interlooping plus some interlooping is obtained in a range from the surface of the web opposite the surface of penetration to a point one-eighth of an inch beyond the surface opposite the surface of penetration whereas a range of barbed penetrations for maximum interlacing and good interlooping has been found to be one-eighth of an inch through the web beyond the surface opposite the surface of penetration and no greater than one-half of an inch through the web beyond the surface opposite the surface of penetration.

As mentioned above, the path of penetration of the needle is at an acute angle to the direction of travel of the web 10. The preferable range in angularity of the path of penetration with respect to a normal through the web has been found to be about 8° to about 12°. This range of angularity is effective both when the longitudinal axis of the shaft of the needle is parallel to the path of penetration and when the axis of the shaft of the needle is at a slight angle to the path of penetration.

As is now apparent, the arrangement of needles traveling at an acute angle to the path of the web provide a needle or non-woven fabric having good tensile and separation strength as well as good compactness and density. Because the needle or non-woven fabric produced by the aforementioned method results in interlooping and as well as some interlacing, the fabric may be subjected to subsequent operations on both sides such as napping with uniform results. The interlooping of fibers causing a subsurface-to-subsurface binding permits the non-woven fabric to be matted without materially reducing its tensile strength or its separation strength. It has been found that by utilizing the aforestated method, a needle or non-woven fabric capable of use in making blankets, outerwear fabrics and the like can be made by punching the fabric at least 600 punches per square inch upon one pass through the opposed patterns of needles.

The amount of interlooping and interlacing of fibers of a needle or non-woven fabric produced according to the foregoing method is a function of the thickness of the finished fabric, the number of punches per linear inch, the angle of the path of penetration, as well as the amount of barbed penetration. However, it will be understood that the aforementioned variables are interdependent if interlooping is to be achieved. Generally, more interlooping of fibers occurs when the needle or non-woven fabric...
produced is one-eighth inch or greater in thickness. Likewise, the more punches per linear inch produces more interlooping whereas the lower end of the range produces more intercizing. Further, more interlooping of fibers occurs at the lower end of the barb penetration range whereas interlacing increases with increased barbed penetration.

Referring back to FIGURES 1, 2 and 3, the improved needle punching apparatus 12 for accomplishing the above described method is best illustrated. The needle punching apparatus 12 includes a frame structure 48 made from suitable vertical standards 50, side frame members 52 and cross members 54. Mounted on the upper side frame members 52, on each side of the frame structure 48 are a pair of spaced parallel vertically extending plates 56 which are adapted to support therebetween the guide plates 36 and 38. The guide plates 36 and 38 are supported in any suitable manner such as disclosed in detail in my aforementioned application Serial Number 29,115. These plates may be adjusted relative to each other so that the spacing between the plates may be varied to conform to the desired compression of the web 10. Side plates 56 are provided with horizontally extending slots 58 and 60. Aligned slots 58 of side plates 56 are adapted to receive the ends of a shaft 62 which supports one pulley 64 of an endless conveyor structure 66. The end portion of shaft 62 which extends outwardly of the plate 56 as shown in FIGURE 1, is provided with a drive sprocket 68.

Slots 60 in plates 56 receive the ends of a shaft 70 which supports an outfeed roller 72. Carried outwardly of the plates 56 on the end of the shaft 70 is a drive sprocket 74 (FIGURE 1). A one-way clutch and brake assembly (not shown) is coupled to the other end of shaft 70 in a manner such as disclosed in my aforementioned application Serial Number 29,115. A driven chain 76 trained around the sprockets 68, 74 and an idler sprocket 78 causes the pulley 64 to be rotated in step-by-step increments when the shaft 70 is rotated in step-by-step increments by the one-way clutch and brake assembly (not shown).

Cooperating with the outfeed roller 72 is a weighted roller 80 carried on a shaft 82 supported in diametrically opposed slots 84. Weights may be provided on the outer ends of the shaft 82 so that the roller 80 bears against the upper surface of the non-woven fabric 14 as it is discharged from the machine.

A crank arm 86 connected to the drive member of the one-way clutch and brake assembly (not shown) is actuated by a connecting arm 88 pivotally connected thereto and to a disk or wheel 89 (FIGURE 2) keyed to a shaft 90 rotatably supported in the bearings pillow blocks 92. Shaft 90 also carries a drive wheel 94 which is rotatable by a belt 96 coupled to a source of power such as the electric motor 98. As will now be understood, continuous rotation of the shaft 90 by the motor 98 will cause the crank 86 to oscillate back and forth. Since the crank is connected to the drive member of the one-way clutch and brake assembly, clockwise movement of the crank will cause rotation of the outfeed roller 72 in a clockwise direction as well as rotation of the pulley 64 and movement of the conveyor structure 66 in a direction of web feed. During counterclockwise movement of the crank 86, the roller 72 and the conveyor structure 66 will be stationary and consequently, there will be no feed of the web 10 through and out of the machine.

As previously stated, the upper needle pattern 22 includes a plurality of downwardly extending needles 30 carried in needle board 26. Likewise, the lower needle pattern 24 includes a plurality of upwardly extending needles 32 carried in a lower needle board 28. Needle board 26 is fixedly mounted on the end of elongated rocker arms 100 which are pivotally supported as indicated at 102 to a pair of vertical standards 104 fixedly secured on opposite side frame members 52 of the frame 48. Lower needle board 28 is fixedly supported as indicated at 106 to the ends of elongated rocker arms 108 also pivotally supported as indicated at 110 to the vertical standards 104.

Connecting rods 112 on opposite sides of the needle boards, pivotally connect the upper needle board 26 to the lower needle board 28 as indicated at 114. Thus, when the lower needle board is moved vertically upwardly and downwardly, the upper needle board 26 is simultaneously moved upwardly and downwardly.

Extending vertically downwardly beneath the lower needle board 28 and fixedly connected thereto is a pair of brackets 116 to which the forward ends of the rocker arms 108 are connected. The brackets 116 are pivotally connected as indicated at 118 to a pair of curved cranks 122 carried on a shaft 124 supported in bearing pillow blocks 126. The shaft 124, which rotates the cranks 122, is provided with a drive sprocket 128 driven by a chain 130 trained about a sprocket 132 keyed to the drive shaft 90.

As is now apparent from the foregoing description and the drawings, the feed of the web 10 in step-by-step increments is timed to the movement of the needle pattern 22 and 24. Drive shaft 90 is rotated by motor 98 and its rotation causes continuous up and down movement of the patterns 22 and 24 about their pivotal axes 102 and 110, respectively. Timed to the up and down movement of the patterns 22 and 24 is the step-by-step feeding of the web 10 between the patterns. This is also accomplished by rotation of the shaft 90 which in turn oscillates the crank arm 86 of the one-way clutch and brake assembly causing step-by-step feeding of the web in timed relationship to movement of needle patterns 22 and 24. In more detail and assuming the upper patterns of needles 22 is on its down stroke, the web 10 will be stationary as the crank arm 86 is moving in counter-clockwise direction. After the array of needles 30 of pattern 22 have penetrated the web orienting the fibers as heretofore described, the array of needles 30 will begin to withdraw from the web. When the needles 30 are completely out of the web and prior to the array of needles 32 of pattern 24 entering in the web, the crank arm 86 will rotate in a clockwise direction to advance the web in the desired increment in its step-by-step movement. Immediately after the web has stopped, the lower pattern of needles 24 will begin to penetrate the web through the web.

Referring now to FIGURE 3, it will be noted that the first few rows of needles 30 and 32 of upper and lower needle patterns 22 and 24 merely pass through the curved inlet portions 40 and 42 of guide plates 36 and 38. Some of these needles do not pass completely through the web as heretofore described but merely enter the web and compress the web in the taping infeed portion 44 of the throat 34. In other words, the needles in the forward portion of the patterns are not entirely effective to cause interlooping and/or interlacing of the loosely matted fibers but they do compress the web to proper thickness and density for passage through the confined throat 34. The contour of the plates 36 38 is such that they conform to the web as it is compressed, that is, they are spaced apart a distance which allows no up and down flapping motion of the web during the needle process.

Throughout the specification, the novel fabric structure or material produced by the novel method and apparatus has been referred to as a “needled or non-woven” fabric structure. It will be understood that the term “needled” or the term “non-woven” includes any fabric structure made primarily from a web of non-woven fibers with or without a woven or non-woven scrim. While the objects and advantages of the method and apparatus of the present invention have been fully and effectively accomplished, it will be understood that the improved method and/or apparatus is subject to some changes and modifications without departing from the
principles and scope of the invention involved. Therefore, the terminology used in the specification is for the purpose of description and not limitation, the scope of the invention being defined in the claims.

I claim:

1. A method of producing a needled fabric material by needling a web of loosely matted fibers comprising the steps of: penetrating one surface of the web while the web is stationary with a first pattern of needles traveling substantially in a path at an acute angle to a median plane through the web, withdrawing the first pattern of needles and advancing the web a small increment, penetrating the opposite surface of the web by an oppositely disposed second pattern of needles traveling substantially in a mirror image path of the path of the first pattern of needles and at an acute angle to the median plane of the web, the path of penetration of said second pattern of needles being such that it engages fibers previously oriented by oppositely disposed needles of said first pattern of needles during the immediately previous path of penetration of the same, withdrawing the second pattern of needles and advancing the web another small increment, and sequentially repeating the above steps.

2. The method defined in claim 1 wherein the first and second patterns of needles are caused to travel in paths which intersect in a median plane of the web.

3. The method defined in claim 1 wherein penetration of said first pattern of needles is effective to at least the surface opposite the surface of penetration of the same thereby orienting fibers in the web so that loops of fibers effected by penetration are arranged beneath the surface of the web opposite the surface of penetration and wherein penetration of the second pattern of needles is effective to at least the surface opposite to the surface of penetration of the same thereby causing fibers to be threaded through previously oriented loops of fibers immediately below the surface of penetration of the second pattern of needles and further, wherein fibers threaded through previously oriented loops of fibers and other fibers are arranged to have loops positioned immediately beneath the surface opposite the surface of penetration of the second pattern of needles.

4. A method of producing a needled fabric from a web of loosely matted fibers comprising the steps of: penetrating one surface of the web while the web is stationary with a first pattern of needles traveling substantially in a path at an acute angle to a median plane through the web, the angle of penetration of the first pattern of needles relative to a normal of the web being at least 8°, withdrawing the first pattern of needles and advancing the web a small increment, penetrating the opposite surface of the web by an oppositely disposed second pattern of needles traveling substantially in a mirror image path of the first pattern of needles and at an acute angle to a median plane through the web, the angle of penetration of the second pattern of needles relative to a normal of the web being at least 8°, withdrawing the second pattern of needles and then advancing the web another small increment, and sequentially repeating the above steps.

5. The method defined in claim 4 wherein the needle patterns of each of said first and second patterns punches the web in a widthwise inch of the same per range of 25 to 75 punches.

6. The method defined in claim 4 wherein each needle of each pattern of needles punches the web in a linear inch within a range of 6 to 20 punches and the needle penetration is at least to the opposite surface and no greater than one-eighth of an inch beyond the opposite surface.

7. The method defined in claim 4 wherein each needle of each pattern of needles punches the web in a linear inch within a range of 4 to 20 punches and the needle penetration is at least to one-eighth of an inch beyond the opposite surface and no greater than one half of an inch beyond the opposite surface.

8. The method defined in claim 4 wherein each needle of each pattern of needles punches the web in a linear inch within a range of 7 to 14 punches.

9. The method defined in claim 4 wherein each of the needle patterns penetrates through the web at least to the surface opposite the surface of penetration but no greater than one half of an inch out of the said surface.

10. A method of producing a needled fabric from a web of loosely matted fibers comprising the steps of: advancing the web in step-by-step increments between oppositely disposed patterns of needles, alternately penetrating the web by the oppositely disposed patterns of needles in successive stationary dwell of the web, each of the penetrations of the web being accomplished in mirror image paths of each other substantially at acute angles to a median plane through the web, the increments of advancement being such that successive alternate penetrations engage fibers previously oriented by the oppositely disposed needles of the immediately previous penetration to cause a chain entanglement of fibers into cohering relationship with each other.

11. A method as defined in claim 10 including coordinating the punching of the needle patterns with the increments of advancement of the web so that the web is penetrated by at least 600 punches per square inch upon one pass through the opposed patterns of needles.

12. The method defined in claim 11 including penetrating the web by each of the needle patterns for each widthwise inch of the web in a range of 25 to 75 punches, and further, punching the web by the needle patterns in a linear inch of the same within a range of 4 to 20 punches for each needle of each pattern of needles.

13. A method as defined in claim 10 wherein the path of penetration of the needle is at an angle to a longitudinal axis through shafts of the needles.

References Cited in the file of this patent

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Patent Number</th>
<th>Inventor</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,000,100</td>
<td>Ochs</td>
<td>June 7, 1892</td>
</tr>
<tr>
<td>502,327</td>
<td>Ochs</td>
<td>Aug. 1, 1933</td>
</tr>
<tr>
<td>547,257</td>
<td>Heaton</td>
<td>Oct. 1, 1935</td>
</tr>
<tr>
<td>742,700</td>
<td>Maussner</td>
<td>Oct. 27, 1903</td>
</tr>
<tr>
<td>921,821</td>
<td>Carlson et al.</td>
<td>Jan. 9, 1917</td>
</tr>
<tr>
<td>1,314,365</td>
<td>Billington</td>
<td>Sept. 2, 1919</td>
</tr>
<tr>
<td>1,454,049</td>
<td>Genth</td>
<td>May 8, 1923</td>
</tr>
<tr>
<td>1,742,338</td>
<td>Bettison</td>
<td>Jan. 17, 1930</td>
</tr>
<tr>
<td>2,896,302</td>
<td>Costello</td>
<td>July 28, 1959</td>
</tr>
</tbody>
</table>