NEEDLE PUNCH MACHINE AND METHOD
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ABSTRACT OF THE DISCLOSURE

Needle punching of un woven batt or fibrous material into a compact coherently oriented fabric structure by intermittent or continuous feeding of un woven batt material in a longitudinal direction through a needle punching operation while simultaneously laterally shifting through a pivot action the batt material to change the feed pattern or to alternatively laterally shift the needle board during the needle punching operation.

BACKGROUND OF THE INVENTION

This invention relates to a new and improved needle punching machine for operation on fibrous material or non-woven material to intermingle the fibers as well as to a new and improved needling method.

Non-woven fabrics such as felt and the like have been produced from wool and wool-like fibers by various mechanical working processes involving ruffling, squeezing and rolling under controlled conditions of temperature and humidity. Needled or non-woven fabrics derive their coherence and strength from interfiber entanglement or intermingling of fibers. Needle looms have been employed for punching the non-felting natural and synthetic fibers in loosely matted batts to obtain coherence from inter fiber entanglement. Generally such needling is accomplished by subjecting the web or batt of loosely matted fibers to needling from a needle board having a plurality of laterally and longitudinally disposed barbed needles wherein such needling is accomplished as the batt of fibers is passed along the reciprocable needle board.

The needles in the needle board are staggered in a special way. On looking at the needle board from the side or laterally into it, no two needles are arranged in the same straight line as is imperative that the needles do not strike the material as it is advanced in a spot that has been previously needled or needle punched. After numerous years of experimentation and development work, a special needle arrangement has been worked out wherein the needle positioning resembles a herringbone pattern. It is of interest to note that there are only a very few needle arrangements from the numerous possible that guarantee an even and regular felting effect. In some instances several passes are made through the needle loom in order to reorient the fibers and achieve the desired interlocking; however, on making these passes there is a likelihood of nonuniform distribution of the holes. Attempts to achieve a greater compactness, strength and a more uniform, positive interfiber entanglement leads to needling a previously needled spot or to striation lines that appear on the surface, which striation lines do not affect the functioning of the material but has a nonaesthetic appearance which prevents their use where appearance is important as in consumer articles.

SUMMARY OF THE INVENTION

The present invention contemplates an apparatus and a needling operation wherein the batt material is compacted to a dense structure having a uniform and positive interfiber entanglement of great strength without striations by feeding batt material in a generally longitudinal direction while simultaneously laterally shifting the batt material relative to the needle board with the alternative of feeding the batt material in a generally longitudinal direction while simultaneously laterally shifting the needle board during the needling operation.

It is an object of this invention to provide a new and improved method and apparatus for providing mechanically bonded nonwoven fabric. A further object of this invention is to provide an improved needled fabric structure that is compact, uniformly dense and interlocked throughout by entanglement of fibers, with greater strength and density than heretofore obtained yet aesthetic in appearance.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and advantages of the present invention become more apparent upon consideration of the following detailed description of the invention when taken in conjunction with the following drawings, in which:

FIG. 1 is a side elevational view of a portion of a needle punching machine of a preferred embodiment of the invention;

FIG. 2 is a front view of the upper portion of the needle punching machine shown in FIG. 1 with a portion broken away to show the needle board;

FIG. 3 is a side elevational view of a modified form of needle punching apparatus with a portion broken away to show the cam controlled needle punching board; and

FIG. 4 is a fragmentary cross-sectional view of the cam control needle punching board taken along line 4-4 of FIG. 3.

DETAILED DESCRIPTION

Referring now to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in FIG. 1 a web or batt of loosely matted fibers designated as 1 moving through a needle punching machine 2 and emerging as a needled or mechanically bonded nonwoven fabric material or batt material designated by the numeral 3. The batt of loosely matted material may be continuous length in a multiplicity of plys as lapped or layered up from a web produced on a carding or garnetting machine or a pneumatic web former, or from some suitable source of supply in a manner well understood in the art.

The needle punching machine 2 comprises a frame structure 4 made from suitable vertical standards 5, lower and upper side frame members 6 and suitable cross members. Mounted on the upper side edges of upper frame members 6 is a plate member 7 which supports a pair of spaced vertically disposed U-shaped plate members 8. Suitably secured to the respective plate members 8 are a pair of spaced horizontally disposed web guide plates 9 and 10 suitably perforated to facilitate the passage of needles therethrough. Guide plates 9 and 10 have converging or curved inlet portions 11 and 12 to define a gradually decreasing infeed portion, which guides the web 1 as it is gradually compressed passing therebetween. Guide plates 9 and 10 cooperate with the U-shaped plate members 8 to define a needle bed, which needle bed may be modified to include merely a horizontally disposed bed upon which the needle is supported upon a pair of spaced pillow blocks 21 (only one shown in FIG. 1). The respective end portions of shaft 20 has suitably mounted thereon a drive wheel 22 having a plurality of spaced crank pins 23 spaced different radii from the axis...
of shaft 20 to provide a variable stroke to the drive mechanism to be described. One end of a crank arm 24 is suitably connected to one of the crank pins 23 while the other end of such crank arm 24 is suitably connected to a bolt 25, which in turn is pivotally connected to one end of a rod 26 which is guided in its reciprocal movement by guide means 27 which is suitably secured to the plate member 18. The respective ends of such rod 26 is connected to a horizontally extending bracket 30 which has a needle board 31 suitably secured thereto for movement therewith. Needle board 31 has an array of downwardly extending needles 32 arranged in a plurality of rows extending transversely of the direction of the travel of the web 1. The needles are adapted to register with the perforations in the respective guides 9 and 10 during the needling operation. The rows of needles are staggered. The forwardly disposed vertical standard 8 has a bracket 35 which suitably supports a motor 36 mounted thereon. Motor 36 has a variable speed transmission 37 connected thereto, which transmission 37 has an input shaft 38 operative to drive a pulley 39 via a belt 40.

The forwardly disposed portion of each U-shaped plate member 8 has a pair of spaced slots 41 and 42. Slot 42 journals a drive shaft 43 which has pulley 39 keyed thereto. Pulley 39 is suitably journaled for rotation in a bushing 44, which bushing 44 is secured to one end of the plate 8. A retaining ring 45 is suitably journaled on the other end of shaft 43 for a purpose to be described. Such other end portion of shaft 43 has a circular cam 46 secured thereto with a compression spring 50 encompassing shaft 43 and having one end portion thereof abutting against the retaining ring 45 while the other end biasing cam 46 outwardly or to the left as viewed in FIG. 2 and into abutting engagement with a roller 51 which is journaled for rotation on the plate member 7. As the pulley 39 is driven by a motor 36, rotation is imparted to the drive shaft 43 which in turn rotates the cam 46 which is biased into engagement with the roller 51 whereby continued rotation of the cam 46 exerts a lateral or transverse shifting of the drive shaft 43 in accordance with the dictates of the surface of cam 46 such that a roller 52 secured to shaft 43 rotates therewith, while simultaneously undergoing a lateral movement therewith in accordance with the dictates of the cam 46. Bushing 44 which is secured to plate member 8, along with pulley 39 allows shaft 43 to move laterally relative thereto. An upper roller 54 journaled on a shaft 55 has its respective end portions received by the slots 41 as suitable pulleys 56 and 57 journaled thereon maintaining such roller 54 in a position in conjunction with the compacted batt material 3 as it emerges from the needling operation. Such roller 54 operates as an idler roller in a manner well known in the art.

In the operation of the apparatus described, which is the preferred embodiment of the invention, the loosely batted batt material is fed by a feed conveyor designated generally as 58 in a rightward direction as viewed in FIG. 1 whereby such batt material is compressed by the converging curved inlet portions 11 and 12. The batt material is guided for the needling operation which is performed between the respective guide plates 9 and 10. Motor 14 is energized such that the output of the variable speed transmission 15 via crank arm 24 reciprocates the needle board 31 in a vertical direction, such that the array of needles 32 penetrate the batt material to perform their needling operation which entangles the fibers and renders the batt material an integral mass. Such needle operation reduces the thickness of the batt material to permit its inimipeted advance between the guide plates 9 and 10. Simultaneously with such action motor 36 via variable speed transmission 37 drives pulley 39 which rotates cam 46 which in turn imparts a transverse movement to the drive roller 53 which in cooperation with the idler roller 54 pulls the batt material through the needling operation. During the transverse movement of the drive roller 53, such roller 53 in cooperation with the idler roller 54 pivots the batt material about the rear portion of the guide plates 9 and 10 closely to the inlet portions 11 and 12 since such batt material is frictionally held by the inlet portions 11 and 12 whereas the forwardly disposed portion is guided by guide plates 9 and 10 in an unrestricted manner so that upon laterally shifting of cam 46 and shaft 43 the batt material is pivoted. Such action is an oscillating pivoting action to the batt material which provides a random needle pattern that is haphazard or dispersed and eliminates striation lines heretofore encountered, thereby rendering an aesthetic effect to the needleled compacted product. With such apparatus, it is feasible to punch 736 needle punches per square inch without striation lines appearing whereas with a comparable apparatus but without oscillating the take-away roller 53, striation lines in the machine direction appeared at 460 punches per square inch.

A modification of the apparatus described is shown in FIG. 3 wherein like parts are designated by like numerals with such apparatus being similar in all respects to the original embodiment described in FIGS. 1 and 2, except for the needleboard which is transversely reciprocated in a manner to be described and in addition thereto the equivalent pulleys 39 are mounted on the respective U-shaped members 8 to prevent laterally shifting of the rollers 53 and 54. If desired such guide rails may be intermittently driven by being coupled to a one-way clutch and brake assembly, which one-way clutches are old and well known in the art and clearly shown by U.S. Pat. 3,090,099, which structure is incorporated herein by reference. Rods 36 in this instance are journaled upon the respective pillow blocks 27 to guide the reciprocation of the needleboard to be described such that the upper end portion of the respective rods 26 are secured to a horizontally disposed support plate 60. Support plate 60 has a pair of spaced downwardly extending brackets 62—62 with inwardly facing 46 which provide guide rails for a carrier member 64. Carrier member 64 has a plurality of rollers 65 which captively engage the respective guide rails 63 to permit the transverse reciprocation of the carrier member relative to the longitudinal pass line of the batt material as it is conveyed through the needle punching apparatus. A needleboard 66 is suitably secured to the lower portion of the carrier member 64 having a plurality of downwardly extending needles 62 arranged in a plurality of rows which extend transversely of the direction of the travel of the web. The upper portion of carrier member 64 is recessed as at 67 with inwardly engaging rib 68 which carries rotation of a cam roller 69 suitably journaled therein for rotation. Mounted on support plate 60 is a motor 70 having its output connected via a pulley 71 and V-belt 72 to drive pulley 73 which in turn provides rotation to a shaft 74, which shaft 74 rotates cam 69 which in turn imparts the transverse reciprocal movement to the needleboard 66. In the operation of this embodiment the loosely batted batt material is fed along conveyor 58 to the converging curved inlet portions 11 and 12 of guide plates 9 and 10 which compresses the batt material and as such batt material is conveyed along such guide plates, motor 70 being energized rotates cam 69 which imparts the lateral reciprocation of the carrier member 64 along with needleboard 66 which changes the pattern of the needling operation which is effected by the vertical reciprocation through the action of the rotation of drive pulley 18 which is driven via drive thereto and an idler roller 54 which reciprocate the guide rods 26 and the bracket 60 along with carrier member 64 and the needleboard 66. In this instance, motor 36 via belt 40 and drive pulley 39 rotates roller 53 which is in cooperation with the roller 54 to move the batt material in a longitudinal direction along the pass line to pull the batt material through the needling operation. With the needling line being pulled up the needle lines heretofore effected on batt material that is fed longitudinally through a needling apparatus and
provide a needling action which effectively compacts the batt material and facilitates the reorientation of the fibers and achieves their effective interlocking. The first-described embodiment provides a more effective means than the second-described embodiment for eliminating the stra-

5 tion lines particularly where a densely needled punched batt material is desired as in the region of 736 punches per square inch, whereas with the same needleboard and without oscillating the front roller 53, stration lines appeared. Thus, with the first-described embodiment, a larger number of punches per pass can be effected without the presence of stration lines which show up in the machine direction.

We claimed:

1. In a machine for needling a web of loosely matted fibrous material for producing a non-woven fabric comprising support means, said support means having guide means with a longitudinally extending pass line for guid-

ing batt material through the apparatus, a carrier member mounted on said support means for reciprocating toward and away from said guide means, a needleboard member mounted on said carrier for reciprocable movement there-

with, said needleboard member having a set of a plurality of needles, conveyor means mounted adjacent to one end of said support means for delivering web material for passage into said guide means, drive means operatively connected to said carrier for reciprocating said carrier toward and away from said guide means for moving said needles into contact with the web material passing through said guide means, a guide roller and a guide roller mem-

ber mounted on the other end portion of said support means having axes of rotation lying normal to said pass line, power-operated means connected to one of said guide rollers for effecting rotation thereof, cam operated means connected to one of said members for reciprocating said one member in a transverse direction relative to said longitudinally extending pass line, and drive means opera-

tively connected to said means for imparting movement thereto.

2. In a machine for needling web material as set forth in claim 1 wherein said guide roller member is mounted on a shaft, said shaft being journaled on brackets attached to said support means for axial movement relative to said support means, said means being a cam with a pattern thereon secured to said shaft for movement there-

with, a roller mounted on said support means abuttingly engaging said cam means, and means biasing said cam means into engagement with said roller.

3. A machine as set forth in claim 1 wherein said needleboard is mounted on said carrier member for move-

ment in a transverse direction relative to said longitudi-

nally extending pass line, said needleboard being recessed to provide a follower abuttingly engaging said cam oper-

ated means.

4. A web punching machine as set forth in claim 3 wherein said cam means includes a bearing mounted on said frame and a rotary cam roller secured to said shaft for rotation therewith, and bearing means connected to said rotary cam roller for biasing said rotary cam roller into abutting engagement with said bearing which thereby imparts movement to said cam roller and said shaft in accordance with the dictates of the pattern on said cam roller.

5. A web punching machine as set forth in claim 4 wherein said shaft has a pulley keyed thereto to permit axial movement of said shaft relative thereto, bearing means one end of said shaft connected to said pulley to mount said pulley on said support frame, said second drive means connected to said pulley for driving said pulley and said shaft, said biasing means comprising a coil spring encompassing the other end of said shaft, said coil spring having one end abutting said support means and the other end abutting said rotary cam roller in rolling engagement with said bearing.

6. A web punching machine for needle punching a web of loosely matted fibrous material comprising support means, a needle bed on said support means having a longitudinal pass line, a feed conveyor located at one end of said needle bed for delivering batt material to said needle bed, a reciprocating needleboard mounted on said support means for movement toward and away from said needle bed, first drive means connected to said needleboard for reciprocating said needleboard, said needleboard having a plurality of needles, a drive roller located at the other end of said needle bed taking away the needled batt material from said needle bed, said drive roller being mounted on a shaft having its axis of rotation lying in a plane that is normal to said longitudinal pass line, second drive means connected to said shaft for imparting movement thereto, an idler roller mounted on said support means closely adjacent to said drive roller, the axis of rotation of said idler roller being parallel to said axis of said drive roller, and cam means connected to said shaft for reciprocating said shaft in an axial direction relative to said longitudinal pass line operative to pivot the fibrous material as it is passed through said needle bed.

7. A web punching machine for needle punching a web of loosely matted fibrous material comprising support means, conveyor means mounted adjacent to one end of said support means for delivering web material for passage into said guide means, a web frame, said support frame having a pair of spaced side members, the one end portion of each of said side members has a slot, a shaft having its respective outer end portions journaled in said slots, the axis of said shaft extending transversely of said web punching machine, a first roller mounted on said shaft for rotating and axial movement therewith, a rotary cam roller secured to one end of said shaft, a drive pulley keyed to the other end of said shaft to permit relative axial movement there-

between, a bearing secured to said drive pulley and one of said side members to prevent axial movement of said pulley, a roller bearing means mounted on said support frame, biasing means mounted on said shaft for biasing said rotary cam roller into abutting contact with said roller bearing means, drive means operatively connected to said pulley for imparting movement thereto, an idler roller mounted between said spaced side members with axis of said idler roller parallel to said support frame, conveyor means mounted closely adjacent to said support frame, biasing means mounted on said support frame for feeding web material into said needle bed, said longitudinal pass line being normal to said axes of said idler roller and said cam roller, a second drive means mounted on said support frame for reciprocating said needleboard.

8. In a machine for needling a web of loosely matted fibrous material for producing a non-woven fabric comprising support means, said support means having guide means with a longitudinally extending pass line for guid-

ing batt material through the apparatus, a carrier member mounted on said support means for reciprocating toward and away from said guide means, a needleboard member having a set of a plurality of needles, conveyor means mounted adjacent to one end of said support means for reciprocating said needleboard, motive means mounted on said carrier for rotating said cam means, conveyor means mounted adjacent to one end of said support means for delivering web material for passage into said guide means, drive means operatively connected to said carrier for reciprocating said carrier toward and away from said guide means for moving said needles into contact with the web material passing through said guide means, a guide roller and a guide roller mem-

ber mounted on the other end portion of said support means having axes of rotation lying normal to said pass line, and power-operated means con-
connected to one of said guide rollers for effecting rotation thereof.

9. The method of producing a needled fabric material by needling a web of loosely-matted fibers comprising the steps of advancing a web of matted fibers along a longitudinal pass line through a needling operation having a forwardly disposed portion and a rearwardly-disposed inlet portion, sequentially oscillating laterally the web of matted fibers to a greater extent at the forwardly disposed portion than at the rearwardly disposed inlet portion, and needle punching such matted fibers between oscillatories thereof.

10. The method of producing a needled fabric as set forth in claim 9 wherein said lateral oscillating is a pivoting action of the web of matted fibers about the rearwardly disposed inlet portion in timed relationship to the needle punching thereof.

11. The method of producing a needled fabric as set forth in claim 10 wherein said needle punching is over 460 punches per square inch.

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