METHOD OF AND APPARATUS FOR PRODUCING A FELT-LIKE FIBROUS MATERIAL

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This invention relates to a method of and apparatus for producing a felt-like fibrous material.

One object of the invention is to provide a novel and improved method of and apparatus for producing in a continuous manner a felt-like fibrous material wherein the direction the fibers are controlled to impart to the material substantially equal tensile strength in any direction.

With these general objects in view and such others as may hereinafter appear, the invention consists of the method of and apparatus for producing a felt-like fibrous material and in the various structures, arrangements and combinations of parts hereinafter described and particularly defined in the claims at the end of this specification.

In the drawings illustrating the preferred embodiment of the invention:

Fig. 1 is a plan view of the present apparatus for producing a felt-like fibrous material in accordance with the present method;

Fig. 2 is a side elevation of the line 2—2 of Fig. 1;

Fig. 3 is a side elevation as viewed from the line 3—3 of Fig. 1;

Fig. 4 is a side elevation as viewed from the line 4—4 of Fig. 1;

Fig. 5 is a detail view in side elevation of the edge combing mechanism for removing the folded edges of the web;

Fig. 6 is a plan view detail of a web of fibrous material passing through the edge combing mechanism; and

Fig. 7 is a detail end view of a marginal edge of the web after being combed.

In general the present invention contemplates a novel method of and apparatus for producing a felt-like fibrous material. In accordance with the present invention a sheet or web-like web of carded fibrous material is delivered to a continuously moving receiving apron or a lapper. The carded web has its fibers disposed substantially parallel and extending in the direction of advance of the web. The lapper is arranged to deposit successive folds or laps of the web on an accumulating apron or conveyor arranged at right angles to the advance of the web, the accumulating conveyor being arranged to travel at a rate of speed such as to dispose successive folds or laps of the web on a conveyor in crisscross relation as it is deposited on such conveyor with a back and forth motion, in a manner such that the leading edge of one angular or diagonal lap coincides with the trailing edge of an underlying lap whose trailing edge extends in the same direction as said leading edge and which has been previously deposited, thus providing a two-ply web or batt in a series of triangular patterns with the fibers in adjacent plies extending substantially at right angles to each other and preferably at an angle of slightly less than 90° as measured at the apices of the triangular patterns adjacent the marginal edges of the two-ply web.

In accordance with one feature of the present invention the folded marginal edges of the two-ply web are then removed, preferably by a combining action distinguished from a cutting or shearing action, whereby to provide a two-ply web of substantially uniform thickness across the full width thereof. The web may then be subjected to a longitudinal drawing or stretching operation as it is advanced, preferably continuously, to dispose the fibers in adjacent webs at an angle of slightly more than 90° at said apices, the two-ply web then preferably being advanced on an adjoining conveyor at a relatively faster rate to accommodate the increased length of the web effect by the drawing operation. In the illustrated apparatus the adjoining conveyor advances the drawn web to a second lapper which deposits successive folds or laps of the web on a second or final accumulating conveyor preferably arranged at right angles to the advance of the two-ply web. In practice for continuous operation the second accumulating conveyor may advance at a relatively slow rate so as to build up a multi-ply web or batt of the desired thickness. The multi-ply web is preferably subjected to a compressing and longitudinal drawing or stretching operation which is arranged to dispose the fibers of adjacent webs at substantially right angles to each other and then the web is subjected to a needle punching operation preferably from both sides of the web. As a result of combing the marginal edges of the two-ply web to remove the folds therefrom the multi-ply web produced is rendered more uniform in both density and thickness. Furthermore, as a result of the various drawing operations to produce a final disposition of the fibers of an arterial web in controlled relation to one another and preferably substantially at right angles to one another, the final felt-like product is characterized by controlled tensile strength in selective directions and preferably by substantially uniform tensile strength in all directions.

Referring now to the drawings as more or less diagrammatically illustrated in Figs. 1 and 2, the bulk fibrous material in staple form is placed in a standard weighing device and feeding device of known structure indicated diagrammatically at 10 and which is arranged to deliver successive weighed loads of the staple fibers to a conventional single doctor garnett or carding machine indicated generally at 12. The garnett machine is arranged to deposit the carded fibers on a continuously moving slatted apron or conveyor 14 forming thereon a single layer or veil-like web 16 of the fibrous material with the fibers arranged substantially parallel and extended in the direction of advance of the conveyor 14. The veil-like web 16 is delivered by the conveyor 14 to a lapper, also of conventional construction and which is indicated generally at 18, having conventional slatted top and bottom aprons 20, 22 arranged to deposit the carded web 16 between reciprocating guide rolls 24, 26 and thence to the upper surface of a slatted accumulating conveyor 28 travelling in a direction at right angles to the advance of the single layer web 16, and guide rolls 24, 26, the path of the web being indicated by the dotted lines in Fig. 2. The accumulating conveyor 28 is arranged to be driven at a relatively fast and adjustable rate so that in operation the apron deposits successive laps or folds in a back and forth motion across the accumulating conveyor the first lap will extend diagonally at an angle of slightly less than 45° with relation to a transverse line across the accumulating conveyor, the second lap extending at a similar angle on the opposite side of said
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3 transverse line. As illustrated in Fig. 1, it will be seen that one angularly deposited lap overlies one-half of a previously angularly deposited lap and that the leading marginal edge of one lap coincides substantially with the trailing edge which extends in the same direction of a previously deposited lap, thus forming a two-ply web 30 having triangular patterns. Since the angular relationship of successive laps relative to a transverse line across the accumulating conveyor is equal to slightly less than 45° it will be seen that the apex adjacent the marginal edge of each triangular pattern will be slightly less than 90° so that the individual fibers of adjacent laps are arranged diagonally in crescentic relation at such angles. In practice it is preferred to adjust the speed of the accumulating conveyor 28 with relation to the rate of deposit of the web onto the accumulating conveyor such as to produce triangular patterns having apex angles adjacent opposed marginal edges of the two-ply web of between 74° and 78°. It will be apparent that such angular disposition may vary with different relative speeds of the lapping mechanism and the accumulating conveyor when different widths of two-ply webs are produced, the important feature being that a two-ply web is formed having similar patterns with the leading marginal edge of one diagonal lap coinciding substantially with that trailing marginal edge of a previously deposited diagonal lap which extends in the same diagonal direction.

The general construction of the garnetting machine 12 and the lapping machine 18, including the driving mechanism indicated generally at 32 may be of conventional form, and the driving mechanism may include an electric motor 33 connected by a belt 35 to a shaft 37. The shaft 37 is in turn connected by a chain and sprocket drive 39 to a conventional traversing gear housing 41 for operating the upper and lower traversing aprons. The construction and operation of such machines as well known, as indicated in the United States patent to Rundlett, No. 1,978,355, issued October 23, 1934, so that a detailed description of such machines and the drives thereon is deemed unnecessary for understanding the present invention.

In the continued operation of the apparatus, as illustrated in Figs. 1 and 3, the two-ply triangular patterned web 30 having folded marginal edges 44, 46 is transferred from the accumulating conveyor 28 to edge combing mechanism indicated generally at 36 and which includes a relatively large diameter driven roller 38 of a length slightly less than the width of the two-ply web and a pair of cooperating weighted idler rolls 40, 42, one at each end of the roller 38 with the outer face of each idler roll disposed flush with the ends of the roller 38. In operation as the two-ply web is passed between the rollers the folded marginal edges 44, 46 of the web extending beyond the ends of the roller 38 are subjected to a combing operation, as indicated in detail in Figs. 5 and 6, to remove the folded edges, thus eliminating the increased thickness normally occurring at such folds. As herein shown, the combing action may be performed by a vibratory doffer comb 48 which may be actuated by a conventional eccentric mechanism indicated generally at 59 in Fig. 5 and driven by a belt connection from a motor 52. As also indicated in Fig. 5, each idler roll 40, 42, one of which is shown, may be individually supported on an arm 54 pivotally mounted on a shaft 56 journaled in a bracket 58 attached to a transverse support 60 which may be stationary and 62 upon which the eccentric vibrating mechanisms 50 are mounted. As illustrated in Figs. 6 and 7, the combing operation removes the folded edges leaving a relatively tapered marginal edge which is conducive to a more even distribution of the fibers in the multi-ply lapped web which may be subsequently formed from the two-ply web in accordance with this present invention and in the continued operation of the apparatus as will be described. The waste material removed from the edges may be received into the open end of a suction pipe indicated at 64 to be carried away from the machine. In practice the surface speed of the large roller 38 corresponds to the linear speed of the accumulating conveyor 28, the path of the material being indicated by dotted lines in Fig. 3. The driving mechanism for the roller 38 of the combination of accumulating conveyor 28 includes a variable speed drive mechanism indicated generally at 87 and having an output shaft connected by a chain and sprocket drive 88 to an intermediate shaft 90 which in turn is connected to a shaft 92 on which the driving pulley for the accumulating conveyor 28 is mounted. The shaft 92 is in turn connected by a chain and sprocket drive 94 to a shaft 96 upon which the large diameter roller 38 of the combing mechanism is mounted, the driving connections thus far described being arranged to drive the accumulating conveyor 28 and the roller 38 at corresponding rates of speed to advance the two-ply web at a uniform rate.

From the description thus far it will be seen that a two-ply lapped web 30 is produced having successive laps arranged in triangular patterns with the fibers of one ply disposed at an angle of about 78°, for example, with relation to the fibers in the other ply as measured at the apices of the triangular patterns adjacent opposed marginal edges of the two-ply web and that the web is then transferred from the accumulating conveyor 28 to the edge combing mechanism 36 which is operative to remove the folded edges. Thereafter the two-ply web is passed between the combing mechanism indicated generally at 66 arranged to stretch the two-ply web a predetermined amount as it is continuously advanced therebetween in order to increase the angular relationship between the fibers in adjacent plies of the web so as to measure more than 90° at said apices, preferably about 110° for example, such stretching being performed to accommodate a subsequent drawing operation in a direction at right angles to the movement of the two-ply web through the drawing mechanism 136 to bring the angular relationship of the fibers back to substantially 90° or at right angles to each other.

As illustrated in Figs. 1 and 3, the drawing mechanism is disposed immediately beyond the edge combing mechanism and comprises a first pair of upper and lower rolls 68, 70 arranged to be rotated at a surface speed substantially corresponding to the linear speed of the accumulating conveyor 38 of a second pair of upper and lower rolls 72, 74 spaced a short distance from the first pair of rolls and arranged to be rotated at a relatively faster surface speed so as to effect the drawing operation as the web passes between the two pairs of rolls. As indicated generally in Fig. 1, in the driving mechanism for driving the various associated elements provision is made for driving the lower rolls of each pair of rolls 68, 70 and 72, 74 at different speeds and also for adjusting the driving mechanism to vary the speeds whereby more or less drawing tension may be applied to the web as it passes between the two pairs of rolls. As herein shown, a main driving housing 76 includes an electric motor 78 and a gearing mechanism including an output shaft 80 connected by a chain and sprocket drive 82 to a variable drive mechanism of any usual or preferred type indicated at 86. As herein shown, the output shaft 84 of the variable speed mechanism is connected by a chain and sprocket drive 98 to a shaft 100 on which the lower roller 70 is carried between the bearings 82 so as to drive such first pair of drawing rolls at a surface speed corresponding to the advance of the web from the accumulating conveyor and the combing mechanism. It will be seen that the adjustment of the variable speed drive to vary the speed of the shaft 84 will vary the speed of the first pair of drawing rolls 68, 70 and the upper and lower rolls 72, 74 may rotate in opposite directions by frictional engagement of the upper roll with the lower, the upper roll being supported so that the weight of
the same will be against the lower roll. The second output shaft 104 of the variable drive mechanism may be connected by a chain and sprocket drive 106 to the shaft 108 on which the lower roll 74 of the second pair of drawing rolls is mounted so as to drive the second pair of rolls at a relatively faster surface speed to effect the drawing operation and which may be adjustable vertically above or below the roll set. The upper and lower drawing rolls 72, 74 may also rotate in opposite directions by frictional engagement of the upper roll with the lower.

As described above, the drawing operation is preferably arranged to stretch the web longitudinally a predetermined and accurately controlled amount so as to increase the angular relationship of the fibers of adjacent webs of the two-ply web from about 76° to about 110° as measured at the apices of the triangular patterns formed by the lapping operation. The web is then transferred to a receiving conveyor or runout apron 112 of a second lapping machine indicated generally at 114 which may also be of any usual or preferred construction and which includes upper and lower traversing aprons 116, 118 as shown in the Figure 3, arranged to deposit the two-ply web between guide rolls 120, 122 onto a second accumulating apron 134 aligned at right angles to the direction of advance of the two-ply web being deposited thereon. The lapping machine 114 is also preferably driven through connections from the second output shaft 104 of the variable drive mechanism which may include chain and sprocket drives 126, 128 to the runout conveyor 112 and a belt drive 130 to the transversing gear box 132 so that in operation adjustment of the variable drive to change the speed of the second pair of rolls 72, 74 will vary the speed of the associated lapping machine elements correspondingly to accommodate the increased length of the drawn web during its continuous advancement.

For continuous operation the accumulating conveyor 124 is arranged to travel at a relatively slow rate of speed with relation to the rate of deposit of the two-ply web thereon so as to build up a multi-ply batt or web of substantial thickness with the transverse edges of successive laps relatively close together as indicated at 136 in Figure 1. As indicated in Figures 1 and 4, the multi-ply batt 134 is then passed through conventional compressing and drawing rolls, indicated at 136, which may be driven through variable drive mechanism, indicated generally at 138, to effect compressing of the batt and longitudinal stretching thereto in a direction such as to dispose the fibers of the several plies at right angles to each other as indicated at 140. As a result of such right angle disposition of the fibers of the web the tensile strength of the web is rendered substantially equal in all directions. As described above, and as illustrated in Figure 1, the two-ply web being deposited on the conveyor 124 is made up of triangular patterns wherein the fibers in adjacent plies are arranged at 110° relative to each other as measured at the apices of the triangular patterns. It will be observed that the multi-ply web or batt 134 is made up of closely lapped increments of the two-ply web having the adjacent plies arranged at 110° at the apices of the triangles, or with the fibers of adjacent plies crossing each other at complementary angles of 70°. Thus, the multi-ply batt is continuously advanced at right angles to the direction of advance of the two-ply web and passed through the drawing rollers indicated at 136 in Figure 4, the triangular patterns will be elongated longitudinally of the multi-ply batt to change the angles at the apices thereof from 110° to 90°, thus decreasing the angularity of the fibers relative to each other. The conventional drawing and compressing unit 136 driven through the variable drive mechanism 138 is capable of adjustment to vary such elongation to effect more or less drawing action as required. The compressed web is then transferred to a slatted feed apron or conveyor 142 which delivers the multi-ply web to a first needle punching mechanism of conventional form, as indicated at 144, to perform a needle punching operation through one side of the web. The continuously advanced web is then guided downwardly under idler rolls 146, 148 and then upwardly and through a second needle punching mechanism, indicated at 150, wherein a second needle punching operation is performed through the opposite side of the web. The construction and mode of operation of the above-mentioned needle punching mechanisms are well known, and detailed description thereof is deemed unnecessary. The completed felt-like fibrous web is then guided upwardly and over idler pulleys 152, 156 and then downwardly to a windup device indicated at 158. The needle punching mechanisms 144 and 150 may be driven through individual driving units indicated generally at 160 and 162 respectively, each driving unit including an electric motor 164 belted to a variable speed mechanism 166 of any usual or preferred form and which in turn is connected by a belt 168 to its respective needle punching mechanism. Thus, the speed of each needle punching mechanism may be varied to accommodate the feed of the web from the lapping machine 114.

In the operation of the illustrated apparatus the relative speeds of the lapping machine 114 and the accumulating conveyor 124 are such as to provide a thickness of about nine layers of the two-ply web in lapped relation, thus forming a completed web of eighteen plies in thickness. It will be observed that the slightly diagonal transverse edges 134 of successive laps of the web being built up on the relatively slowly moving accumulating conveyor 124 comprise the combed edges of the two-ply web, and in accordance with one feature of the invention such combed edges when passed through the compressing rolls 136 become more uniformly compressed and blended with adjacent portions of the web to produce a uniaxial felt-like web of substantially uniform thickness and density and with a substantially uniform distribution of fibers. If such folded edges were not removed, the transverse edges would form distinct lines in the multi-ply web. Furthermore, if such edges were trimmed in the conventional manner, such as by shearing, the fibers of the two-ply web along the marginal shear line are squeezed together, and during subsequent lapping to build up the multi-ply web, such shear lines would also cause uneven distribution of the fibers resulting in slight but nevertheless visible transverse lines in the completed felt-like web. Formation of these objectionable lines are avoided by the present combination.

It will also be appreciated that the speeds for the speeds of the various associated elements may be adjusted to produce other angular dispositions of the fibers in the completed web whereby the tensile strength in one direction may be greater than that in a direction at right angles thereto if desired.

From the above description it will be seen that the present novel method and apparatus is adapted to produce a superior felt-like fibrous material of substantially uniform thickness and density and which is further characterized by a balanced and controlled orientation of the fibers so that the completed product may have equal or different tensile strength in different directions.

While the invention has been described in connection with the production of a needle felt it will be understood that other felt-like materials may be produced, including fibrous materials which have been felted or needled or pressed.

While the preferred embodiment of the invention has been herein illustrated and described, it will be understood that the invention may be embodied in other forms within the scope of the following claims.

Having thus described the invention, what is claimed is:

1. In a continuous method of producing a felt-like fibrous material, the steps comprising: advancing a
single continuous length of a thin fibrous web having a majority of its component fibers extending longitudinally thereof and in substantially parallel relation, then subjecting the web to a first lapping operation by depositing successive increment lengths of the single continuous web on an accumulating conveyer moving in a direction at right angles to the advance of the thin fibrous web and moving the successively deposited increments on said accumulating conveyer to form a series of laps with the trailing and leading edges of successive laps extending in opposite diagonal directions and with a triangular portion of the previously deposited lap forming a relatively thick web and elongating the two-ply web after the first lapping operation to change the angularity of the fibers in adjacent plies, then subjecting the relatively thick web to a needle punching operation to maintain the angular relationship of the plies.

2. In a continuous method of producing a felt-like fibrous material, the steps comprising: advancing a single continuous length of a thin fibrous web having a majority of its component fibers extending longitudinally thereof and in substantially parallel relation, then subjecting the web to a first lapping operation by depositing successive increment lengths of the single continuous web on an accumulating conveyer moving in a direction at right angles to the advance of the thin fibrous web and moving the successively deposited increments on said accumulating conveyer to form a series of laps with the trailing and leading edges of successive laps extending in opposite diagonal directions and with a triangular portion of the previously deposited lap forming a relatively thick web, then subjecting the two-ply web to a second lapping operation at right angles to the first lapping operation forming a relatively thick web having relatively closely spaced laps, and then elongating the relatively thick web at a slow rate relative to the movement of the two-ply web.

3. Apparatus for producing a felt-like fibrous material comprising, in combination, means for forming and advancing a felt-like web of carded fibrous material having the fibers thereof arranged substantially parallel and extended in the direction of advance, a roller having an accumulating conveyer arranged at right angles to the roller and driven at a relatively fast rate to cause successive laps of the web to be deposited in opposite diagonal directions to form a two-ply web in triangular patterns with the fibers in one ply arranged diagonally with relation to the fibers in its adjacent ply, means for combing the marginal edges of the two-ply web to remove the folded edge portions, means for drawing the web to change the angular relationship of the fibers of adjacent plies, a second roller having a receiving apron arranged to travel at an increased speed to accommodate the increased length of the drawn web, and having an accumulating apron at right angles to the second roller travelling at a relatively slow rate to cause successive laps of the web to build up a multi-ply web of substantial thickness, and means for the said draw rolls through which the multi-ply web is passed to again change the angular relationship of the fibers in adjacent plies.

4. The method as defined in claim 3 wherein the relatively thick web after the second lapping operation and elongation is compressed and subjected to a needle punching operation to maintain the angular disposition of the fibers as produced by said second elongation.

5. The method as defined in claim 2 wherein the movements of the two-ply web and of the relatively thick web are continuous with the movement of the thick web at a slow rate relative to the movement of the two-ply web.

6. Apparatus for producing a felt-like fibrous material comprising, in combination, means for forming and advancing a felt-like web of carded fibrous material having the fibers thereof arranged substantially parallel and extended in the direction of advance, a roller having an accumulating conveyer arranged at right angles to the roller and driven at a relatively fast rate to cause successive laps of the web to be deposited in opposite diagonal directions to form a two-ply web in triangular patterns with the fibers in one ply arranged diagonally with relation to the fibers in its adjacent ply, means for combing the marginal edges of the two-ply web to remove the folded edge portions, means for drawing the web to change the angular relationship of the fibers of adjacent plies, a second roller having a receiving apron arranged to travel at an increased speed to accommodate the increased length of the drawn web, and having an accumulating apron at right angles to the second roller travelling at a relatively slow rate to cause successive laps of the web to build up a multi-ply web of substantial thickness, and means for the said draw rolls through which the multi-ply web is passed to again change the angular relationship of the fibers in adjacent plies.

7. Apparatus as defined in claim 6 wherein provision is made for needling the web to produce a felt-like fibrous material of substantially uniform thickness and density, said provision for needling the web including a plurality of closely spaced needles reciprocated through the web to force some of the fibers vertically into the body of the multi-ply web to lock the fibers together and to maintain the remaining fibers in the angular relationship effected by the second drawing operation.

8. Apparatus as defined in claim 6 wherein said first lapper is arranged to dispose the laps in a manner such that the initial diagonal relationship of the fibers of successive laps is slightly less than 90° as measured at the apices of said triangular patterns; wherein the first drawing means is constructed and arranged to effect arrangement of the fibers in adjacent plies at an angle of slightly more than 90° as measured at said apices; and wherein the compressing and drawing rolls are constructed and arranged to effect arrangement of the fibers of adjacent webs substantially at right angles to each other whereby to produce a felt-like fibrous material having substantially equal tensile strength in all directions.
with the folded edges extended beyond the ends of the roller, a pair of hold down rolls cooperating with the ends of the supporting roller, and a vibratory comb on each side of the web arranged to remove the folded edge portions as the web passes between said rolls.

10. Apparatus as defined in claim 9 wherein the first drawing means comprises two pairs of driven feed rolls arranged in slightly spaced relation, one pair of feed rolls being rotated to provide a surface speed corresponding to the linear speed of the first accumulating conveyor, the second pair of rolls being rotated at a relatively faster surface speed to effect the drawing operation.

11. Apparatus as defined in claim 9 which includes variable driving means operatively connected to drive the accumulating conveyor and the first pair of rolls at one speed, and to drive the second pair of rolls and the receiving conveyor of said lapper at a faster rate of speed.

12. Apparatus as defined in claim 6 which includes means for selectively varying the drawing operations to produce a final web having a predetermined tensile strength in any direction.

13. Apparatus for producing a felt-like fibrous material comprising, in combination, means for forming and advancing a veil-like web of carded fibrous material having the fibers thereof arranged substantially parallel and extended in the direction of advance, a lapper having an accumulating conveyor arranged at right angles to the lapper and driven at a relatively fast rate to cause successive laps of the web to be deposited in opposed diagonal directions to form a two-ply web in triangular patterns with the fibers in one ply arranged diagonally with relation to the fibers in its adjacent ply, means for combing the marginal edges of the two-ply web to remove the folded edge portions, means for drawing the web to change the angular relationship of the fibers of adjacent plies, a second lapper having a receiving apron arranged to travel at an increased speed to accommodate the increased length of the drawn web, and having an accumulating apron at right angles to the second lapper travelling at a relatively slow rate to cause successive laps of the web to build up a multi-ply web of substantial thickness.

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