March 8, 1960 C. J. NELSON 2,927,350

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

Filed Aug. 8, 1956 3 Sheets-Sheet 1

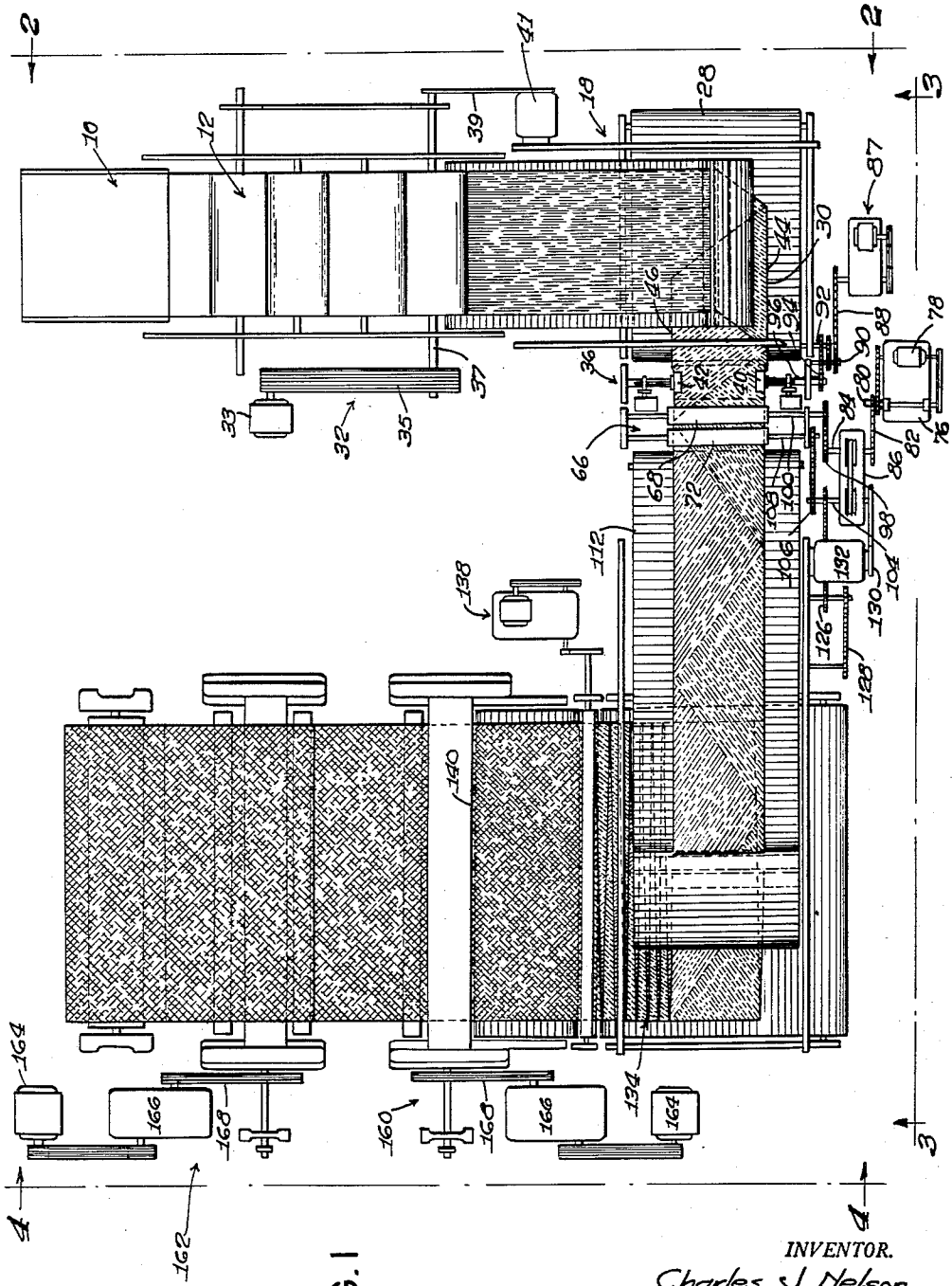


FIG. 1

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Filed Aug. 8, 1956 3 Sheets-Sheet 2

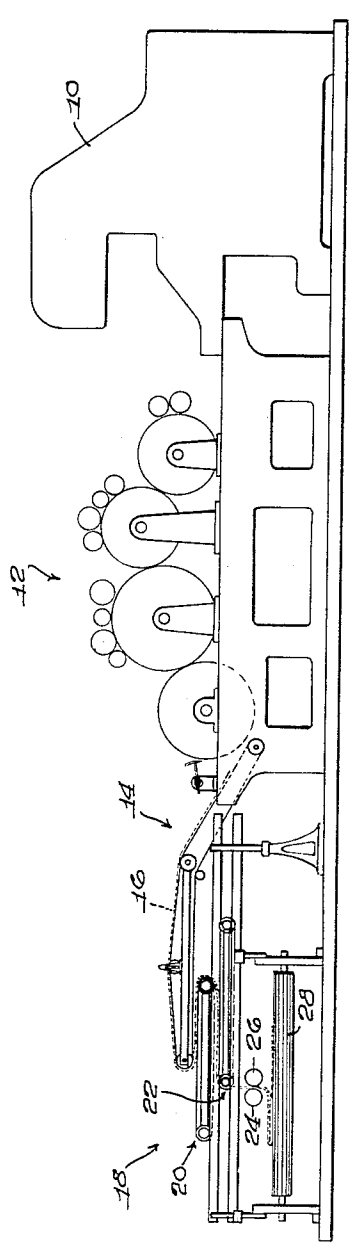


FIG. 2

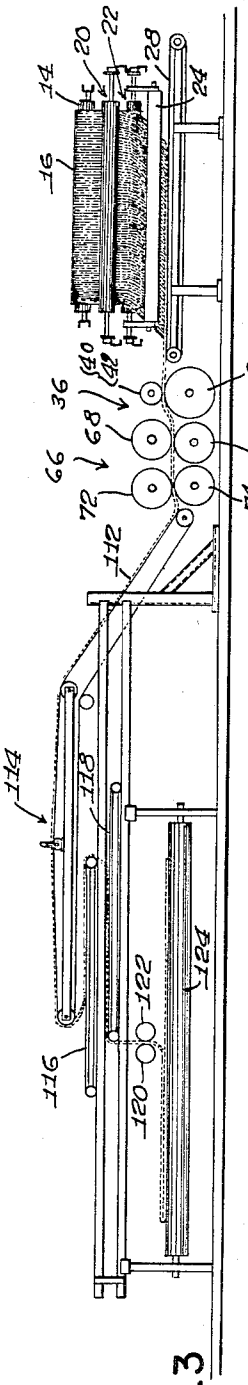


FIG. 3

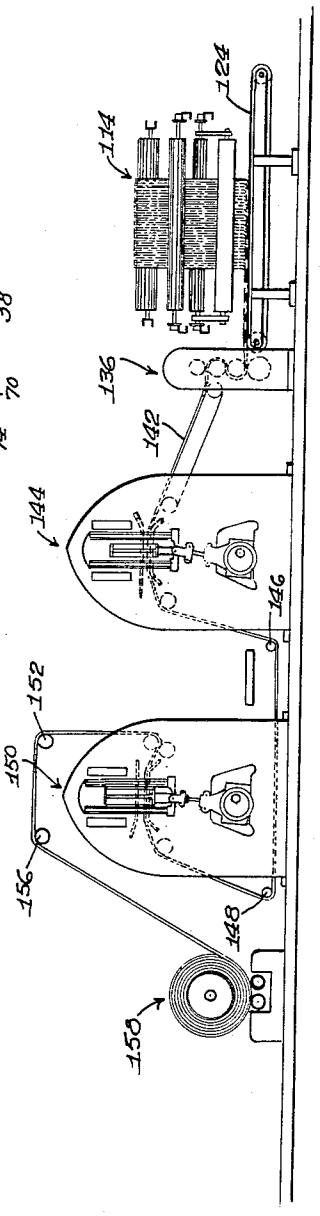


FIG. 4

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

Filed Aug. 8, 1956 3 Sheets-Sheet 3

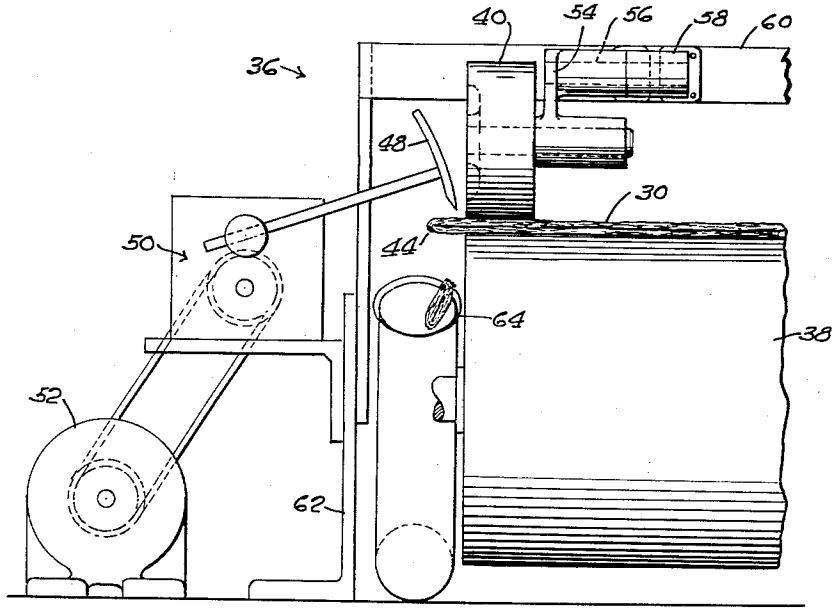


FIG. 5

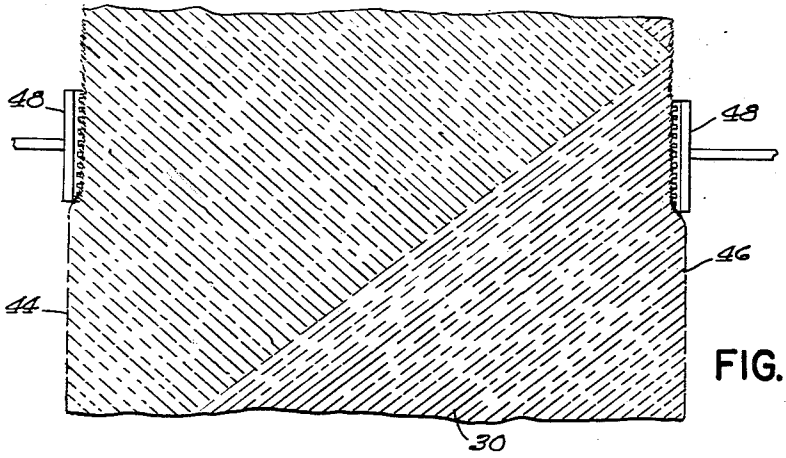


FIG. 6



FIG. 7

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2,927,350

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

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Application August 8, 1956, Serial No. 602,826

13 Claims. (Cl. 19—163)

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 angularity between the fibers is controlled to impart to the material predetermined tensile strength in different directions.

A further and more specific object is to provide a novel method of and apparatus for producing felt-like fibrous materials wherein the angularity between the fibers may be 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 in 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 as viewed from 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 elevtaion 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 veil-like web of carded fibrous material is delivered to a continuously moving receiving apron of 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 conveyer arranged at right angles to the advance of the carded web, the accumulating conveyer being arranged to travel at a rate of speed such as to dispose successive laps of the web diagonally across the accumulating conveyer in crisscross relation as it is deposited on such conveyer with a back and forth motion and 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 as 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 effected by the drawing operation. In the illustrated apparatus the adjoining conveyer advances the drawn web to a second lapper which deposits successive folds or laps of the web on a second or final accumulating conveyer 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. Thereafter 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 adjacent webs 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 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 doffer 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 conveyer **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 conveyer **14**. The veil-like web **16** is delivered by the conveyer **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** to between reciprocating guide rolls **24**, **26** and thence to the upper surface of a slatted accumulating conveyer **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 conveyer **28** is arranged to be driven at a relatively fast and adjustable rate so that in operation as the apron deposits successive laps or folds in a back and forth motion across the accumulating conveyer the first lap will extend diagonally at an angle of slightly less than 45° with relation to a transverse line across the accumulating conveyer, the second lap extending at a similar angle on the opposite side of said

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** in triangular patterns. Since the angular relationship of successive laps relative to a transverse line across the accumulating conveyer 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 crisscross relation at such angles. In practice it is preferred to adjust the speed of the accumulating conveyer **28** with relation to the rate of deposit of the web onto the accumulating conveyer 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 conveyer when different widths of two-ply webs are produced, the important feature being that a two-ply web is formed having triangular 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 are 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 therefor 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 conveyer **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 conventional eccentric vibrating mechanism indicated generally at **50** 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** journalled in a bracket **58** attached to a transverse girt **60** which may be supported between standards **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 the 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 conveyer **28**, the path of the material being indicated by dotted lines in Fig. 3. The driving mechanism for the roller **38** of the combining mechanism and for the accumulating conveyer **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 drive pulley for the accumulating conveyer **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 conveyer **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 conveyer **28** to the edge combing mechanism **36** which is operative to remove the folded edges. Thereafter the two-ply web is passed between drawing 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 conveyer, and 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 gear reducing mechanism having 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** of the first pair of drawing rollers is mounted so as to drive such first pair of drawing rolls at a surface speed corresponding to the advance of the web from the accumulating conveyer 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 rollers. The upper and lower rolls **68, 70** 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 adjustably varied to effect more or less drawing action as required. 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 above described, 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 conveyer 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 Fig. 3, arranged to deposit the two-ply web between guide rolls 120, 122 onto a second accumulating apron or conveyer 124 travelling 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 conveyer 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 advance.

For continuous operation the accumulating conveyer 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 134 in Fig. 1. As illustrated in Figs. 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 thereof in a direction such as to dispose the fibers of each 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 above described, and as illustrated in Fig. 1, the two-ply web being deposited on the conveyer 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 their various 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, as 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 Fig. 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 conveyer 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 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 conveyer 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 conveyer 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 unitary 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 combing operation. It will also be apparent that the controls 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 a succeeding lap overlying a triangular portion of the previously deposited lap forming a two-ply web in a series of triangular patterns, regulating the rate of conveyer movement with relation to the speed with which the increment lengths are deposited so as to maintain the trailing diagonal edge of one lap substantially coinciding with the leading edge extending in the same diagonal direction of a previously deposited lap, and 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, the webs being continuously moved during the entire method, compressing the relatively thick web and elongating the same to change the angularity of the fibers in adjacent plies, and 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 a succeeding lap overlying a triangular portion of the previously deposited lap forming a two-ply web in a series of triangular patterns, regulating the rate of conveyer movement with relation to the speed with which the increment lengths are deposited so as to maintain the trailing diagonal edge of one lap substantially coinciding with the leading edge extending in the same diagonal direction of a previously deposited lap, elongating the two-ply web after the first lapping operation to change the relative angularity of the fibers in adjacent plies, 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 after the second lapping operation to again change the angularity between the fibers of adjacent plies in a direction at right angles to said first elongation, the webs being continuously moved during the entire method.

3. 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 a succeeding lap overlying a triangular portion of the previously deposited lap forming a two-ply web in a series of triangular patterns, regulating the rate of conveyer movement with relation to the speed with which the increment lengths are deposited so as to maintain the trailing diagonal edge of one lap substantially coinciding with the leading edge extending in the same diagonal direction of a previously deposited lap, the relative movement during the first lapping operation being regulated so that the fibers of one ply extend at an angle of slightly less than 90° with relation to the fibers of the second ply as measured at the apex of one of the triangular patterns, elongating the two-ply web to increase the angularity of the fibers in the first and second plies of the two-ply web to slightly more than said 90°, 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 in a direction at right angles to said first elongation to decrease such angularity to about 90°, the webs being continuously moved during the entire method.

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 3 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 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 conveyer 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, and compressing and drawing 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.

9. Apparatus as defined in claim 6 wherein the combing means includes a roller arranged to support the web

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 conveyer, the second pair of rolls being rotated to provide 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 conveyer and the first pair of rolls at one speed, and to drive the second pair of rolls and the receiving conveyer of the second 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 conveyer 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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