

Sept. 19, 1961

N. L. OLKEN

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FABRIC AND METHOD OF AND APPARATUS FOR PRODUCING THE SAME

Filed July 1, 1955

5 Sheets-Sheet 1

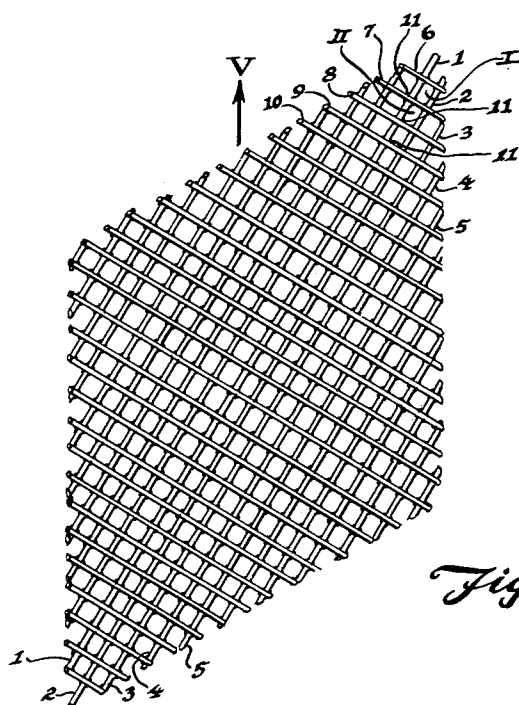


Fig. 1

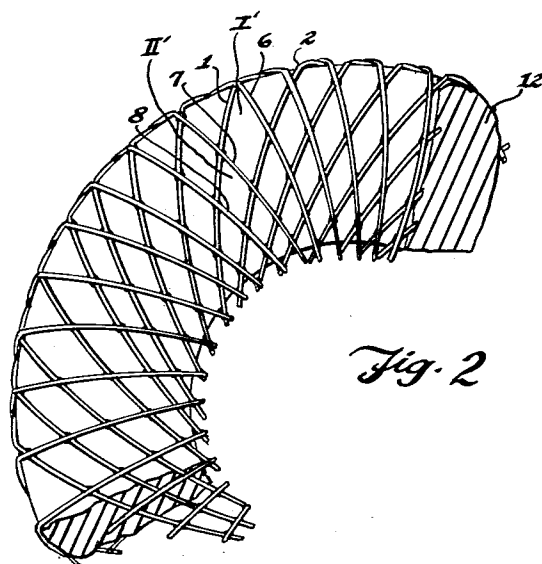


Fig. 2

INVENTOR.
NEIL L. OLKEN
BY *Rines and Rines*
ATTORNEYS

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5 Sheets-Sheet 2

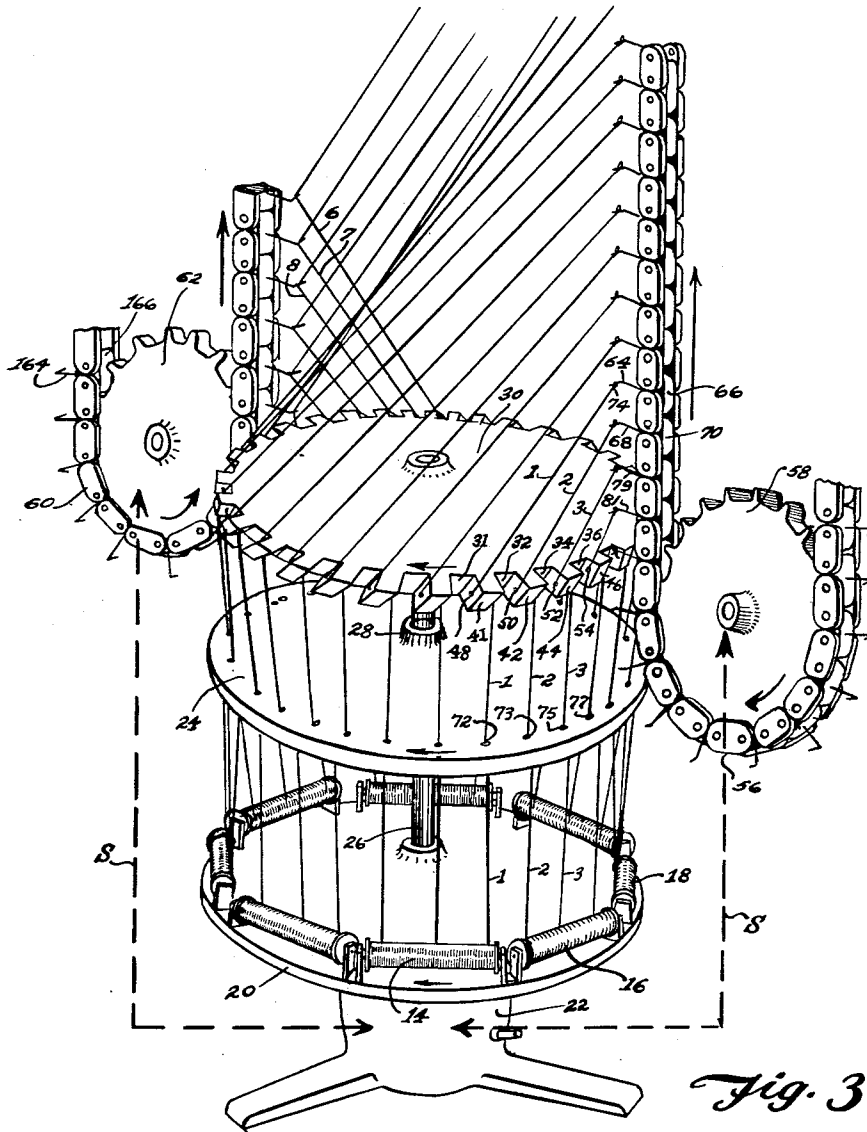


Fig. 3

INVENTOR.
BY *NEIL L. OLKEN*
Rines and Rines
ATTORNEYS

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5 Sheets-Sheet 3

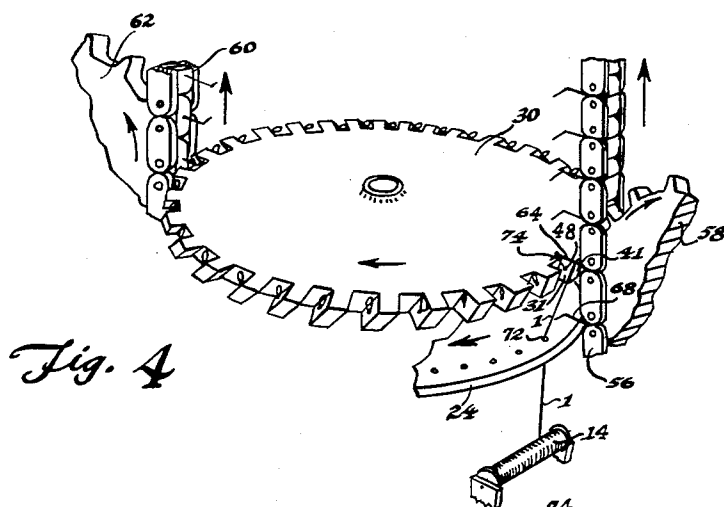


Fig. 4

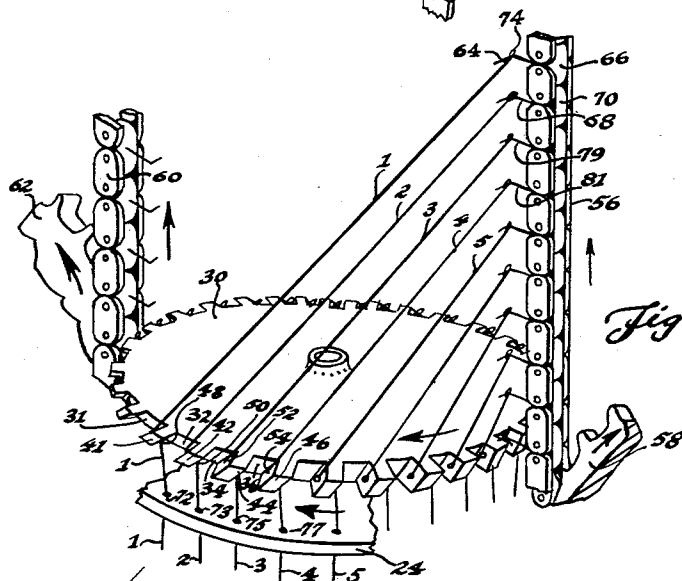


Fig. 5

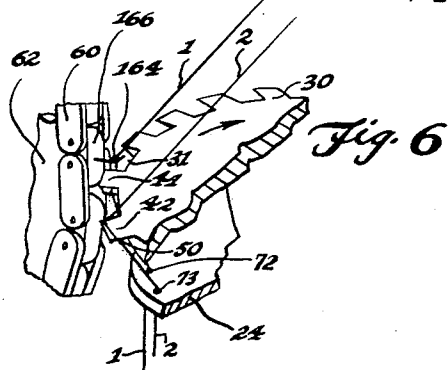


Fig. 6

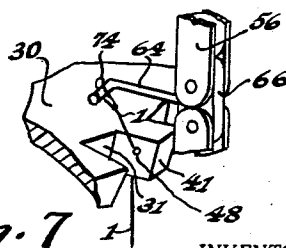


Fig. 7

INVENTOR.

NEIL L. OLKEN

BY

Rines and Rines

ATTORNEYS

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N. L. OLKEN

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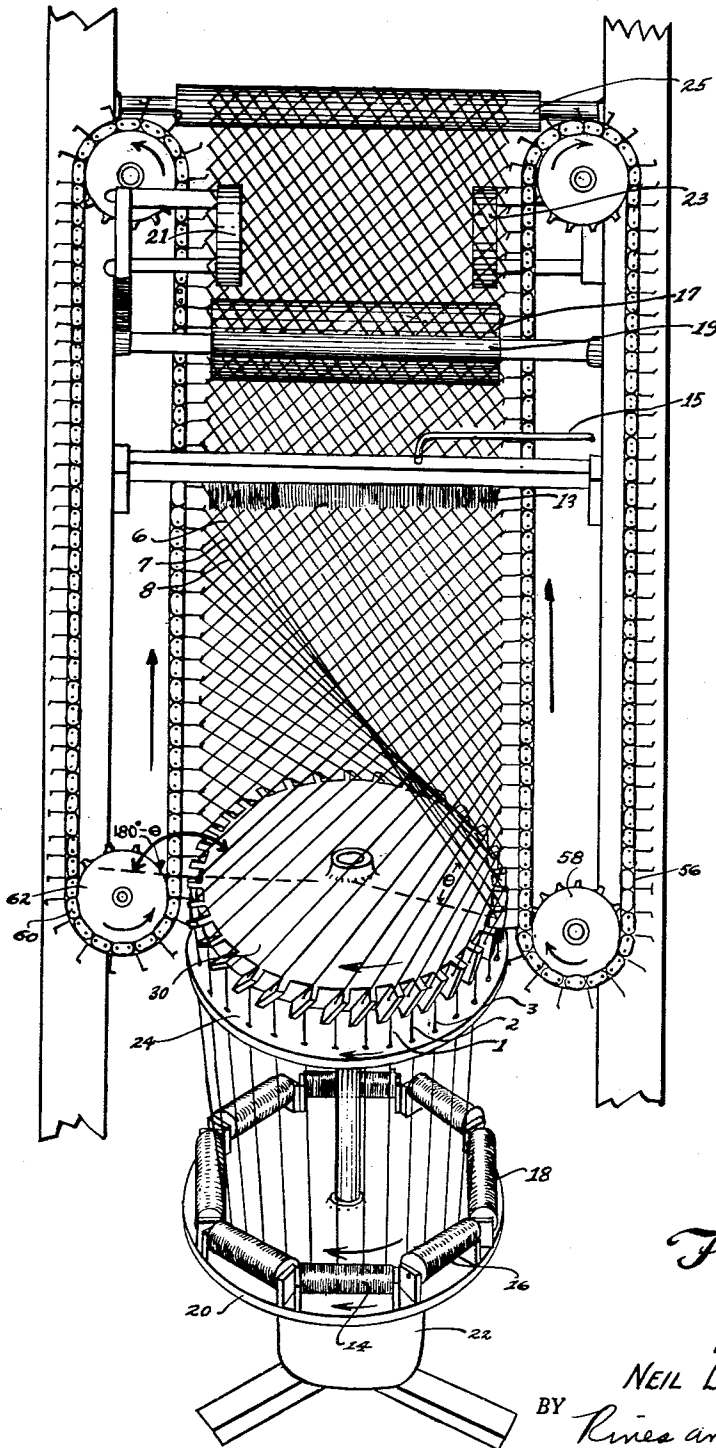


Fig. 8

INVENTOR.
NEIL L. OLKEN
BY *Rines and Rines*
ATTORNEYS

Sept. 19, 1961

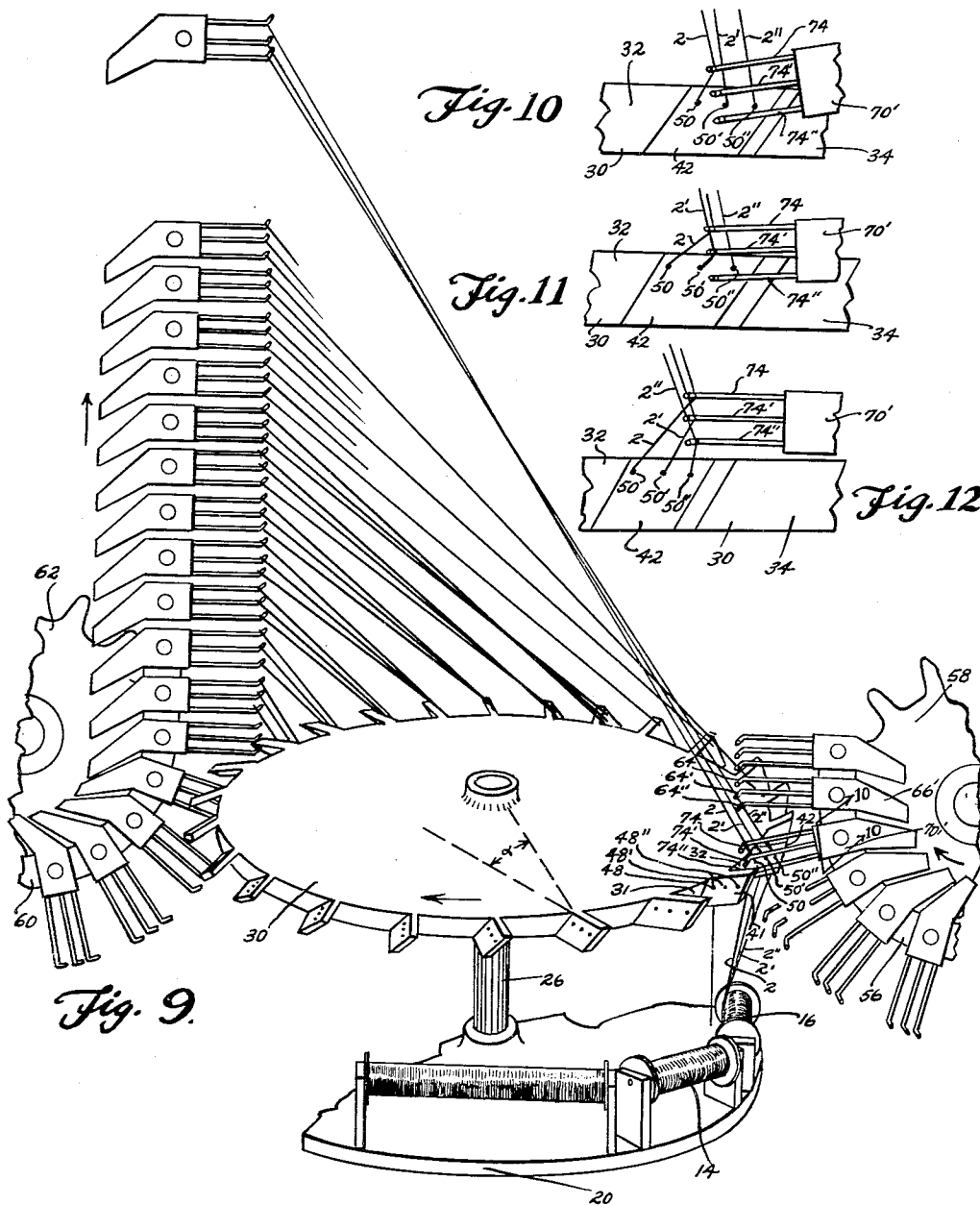
N. L. OLKEN

3,000,432

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5 Sheets-Sheet 5



INVENTOR.
NEIL L. OLKEN
BY *Rines and Rines*
ATTORNEYS

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3,000,432

FABRIC AND METHOD OF AND APPARATUS FOR PRODUCING THE SAME

Neil L. Olken, 76 Robbins Road, Watertown, Mass.

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14 Claims. (Cl. 154—1.7)

The present invention relates to fabrics and, more particularly, to self-supporting fabric structures of the non-woven type.

It has heretofore been proposed to utilize non-woven fabrics of adhesively secured plastic threads and the like for such purposes as, for example, strength-imparting or reinforcing layers in a laminated or ply material. A fabric of this character is stronger than a similar woven fabric in view of the fact that the threads may remain flat and without bends. Unfortunately, however, such prior-non-woven fabrics, as later discussed in more detail, resist dimensional deformation and are not particularly suited to fit curved or discontinuous surfaces and the like. The complexity of the apparatus and the method steps required for the manufacture of such non-woven fabrics has also mitigated against their commercial utility.

An object of the present invention, however, is to provide a new and improved non-woven fabric that shall not be subject to any of the above-mentioned disadvantages, and that, to the contrary, shall have the very desirable property, among others, that it is capable of dimensional deformation or change of relative dimensions under stress. In summary, the fabric of the present invention comprises first and second substantially planar groups of substantially parallel strands laminated together with the strands of one group crossing the strands of the other group and with the strands of each group preferably making an acute angle with the direction of the length of the fabric, the strands of the groups being adhesively joined at the points of crossing only. Preferred constructional details are later more fully treated.

Another object is to provide a new and improved method of manufacture of such non-woven fabrics that is less intricate, less expensive and more rapid than prior-art proposals.

Still a further object is to provide a new and improved preferred apparatus for carrying out the manufacturing steps.

Other and further objects will be explained hereinafter and will be more particularly pointed out in the appended claims.

The invention will now be described in connection with the accompanying drawings, FIG. 1 of which is a perspective view of a portion of a preferred non-woven fabric constructed in accordance with the present invention;

FIG. 2 is a similar fragmentary view of the fabric of FIG. 1 as applied to a curved surface;

FIG. 3 is a perspective view of a preferred apparatus for manufacturing the fabric of FIGS. 1 and 2, with some of the parts being shown fragmentary in order not to confuse the disclosure;

FIGS. 4, 5 and 6 are similar fragmentary views of portions of the apparatus of FIG. 3 in various positions of operation;

FIG. 7 is a similar view, upon an enlarged scale, of a detail;

FIG. 8 is a view similar to FIG. 3, though on a somewhat reduced scale, illustrating further details of the apparatus;

FIG. 9 is a further fragmentary perspective view of a modified apparatus; and

FIGS. 10 to 12 are fragmentary side elevations, taken

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along the line 10—10 of FIG. 9, looking in the direction of the arrows, and representing successive positions of operation.

The non-woven self-supporting fabric of the present invention is shown in FIG. 1 as comprising a first substantially planar group of substantially parallel strands, threads or yarn and the like, 1, 2, 3, 4, 5, etc., hereinafter referred to as strands. The strands are shown biased or oriented diagonally at an acute angle to the vertical direction V of the length of the fabric and they are preferably substantially equally spaced from one another. That angle may, for example, be of the order of forty-five degrees, more or less. An adjacent second planar group of similar substantially parallel strands 6, 7, 8, 9, 10, etc. is shown disposed forward of the strands of the first group and oriented diagonally at a similar but reverse acute angle to the direction V of the length of the fabric. In the case of the forty-five degree angle, before mentioned, the strands, 6, 7, 8, 9, 10, etc. of the second group will thus cross the strands 1, 2, 3, 4, 5, etc. of the first group substantially orthogonally. The strands of the groups 1, 2, 3, 4, 5, etc. and 6, 7, 8, 9, 10, etc. are adhesively joined only at the points of crossing, as shown at 11, enclosing substantially rectangular areas therebetween which may, if desired, be squares. The substantially rectangular area bounded by the crossed strands 1, 7, 2, 6, is shown at I; the similar area bounded by the crossed strands 1, 8, 2, 7, is shown at II; and so on. The strands may be of any desired fiber such as, for example, Fiber-glas, cotton, rayon, or nylon and the like.

Though the fabric of the present invention is a self-supporting structure, in view of the nature of the orientation of the two planar groups of threads before-described, stress or tension applied to the fabric with a component either in the direction V or at right angles thereto, will cause the fabric to undergo relative dimensional changes; i.e., to stretch or expand, either in or out of parallelism, depending upon the applied forces. This is to be contrasted with prior-art non-woven fabrics in which more than two groups of strands are laminated together at different angles and thus produce a relatively rigid, substantially non-deformable structure. This is because, in such multi-group fiber laminates, the areas bounded by the points of intersection of the strands are chiefly of substantially triangular shape; whereas, in accordance with the present invention, they are inherently always of substantially rectangular configuration. The triangular construction, of course, resists deformation, whereas the rectangular structure is easily deformable.

This advantage of the fabric of the present invention is particularly demonstrated in FIG. 2 from which it is evident that the fabric can be easily fitted or shaped over curved or other surfaces smoothly and with appropriate relative dimensional changes. As an illustration, it will be observed that the before-mentioned areas I and II of FIG. 1 are of substantially rectangular contour and of substantially the same area. In FIG. 2, however, in accommodating the curved nature of, for example, an annular form 12, the rectangular area bounded by the strands 1, 7, 2, 6, shown at I in FIG. 1, has become deformed or distorted into a relatively large rhombic configuration I' in FIG. 2; whereas the previously rectangular area II, bounded by the strands 1, 8, 2, 7, has become somewhat less distorted as a result of less curvature-stressing, thus producing a somewhat rhombic enclosed area II' smaller than the area I'. This deformation feature of the fabric of the present invention, therefore, enables the fabric to be smoothly fitted or shaped to surfaces of any desired configuration or curvature. As an illustration, the curved fabric of FIG. 2 may be adapted

for use as a reinforcement in tubular tires. The fabric is, of course, also of utility in flat sheets.

It is next in order to describe a preferred method of and apparatus for manufacturing the fabric of FIGS. 1 and 2. Referring to FIG. 3, beams, cones or spools containing windings of the fiber strands are shown at 14, 16, 18, etc. disposed peripherally about a platform 20 that may be rotated or revolved in a preferably horizontal plane in the direction of the arrow thereupon, by a motor 22. It is preferable that from each of the beams 14, 16, 18, etc. a plurality of the strands are supplied upward to and through peripheral apertures 72, 73, 75, 77, etc. in a circular reed 24, thereby providing an array of strands disposed substantially to define a cylinder extending upward in a vertical direction. The strand 1, for example, is shown extending from the beam 14 upward through the aperture 72; the strand 2, from the beam 16, through the aperture 73; the strand 3, from the beam 18, through the aperture 75; and so on. The reed 24 is rotated as unit with the beam-containing platform 20 by a shaft 26 that is driven from the motor 22 and rigidly secured to the reed 24 at the central mounting 28. Mounted upon an upward extension of the same shaft 26 and rotatable as a unit together with the reed 24 and the platform 20 is a further platform that will hereinafter be referred to as a pick-up plate 30. The periphery of the plate 30 is serrated to provide a plurality of successive recesses or slots 31, 32, 34, 36, etc. which are cut on a bias to the vertical so that the projections 41, 42, 44, 46, etc. therebetween are of substantially trapezoidal shape in cross-section. The purpose of this construction will be hereinafter explained. Each of the projections 41, 42, 44, 46, etc. is provided with a transversely extending strand-receiving guide or aperture shown, respectively, at 48, 50, 52, 54, etc., through which the strands may pass, from right to left, as illustrated. The strand 1 emerging from the aperture 72 in the reed 24 thus passes through the guide 48 in the projection 41 of the pick-up plate 30; the strand 2 emerging from the aperture 73 passes through the guide 50 in the projection 42; the strand 3 emerging from the aperture 75 passes through the guide 52 in the projection 44; and so on.

At the sides of the pick-up plate 30, at substantially diametrically opposite points or positions, there is disposed a pair of endless conveyors 56 and 60. The conveyors 56 and 60 are disposed in a vertical plane substantially perpendicular to the horizontal plane of the pick-up plate 30. The right-hand conveyor 56 is shown of the preferred link-chain variety, driven by a gear 58. The left-hand endless conveyor 60 is shown similarly of the link-chain type, being driven by a similar gear 62. Other types of conveyors may, of course, also, be utilized. Mounted between the successive pairs of adjacent links of each of the chains 56 and 60 are a plurality of successively disposed pick-up hooks, loops, or needles, soldered or otherwise secured to the intermediate successive links of the chain and extending outward from the links. The hooks are preferably of L-shape, as more particularly shown in FIG. 7, and lie in planes normal to the corresponding links. Thus, for example, the pick-up loop 64 of the conveyor 56 is shown secured to the link 66 and extends to the left substantially horizontally. The next lower pick-up loop 68 is shown similarly secured to the adjacent link 70, and so on, for the remaining links of the conveyor 56. The conveyor 60 is similarly provided with pick-up hooks, such as the hook 164 secured to the link 166. The gears 58 and 62 are oppositely driven so as to advance the conveyors 56 and 60 with the respective left and right-hand portions thereof passing vertically upward in the direction of the arrows. The conveyor gear 58 is synchronously operated with respect to the operation of the motor 22 so that successive pick-up hooks of the conveyor 56 are advancing through corresponding successive recesses of the pick-up plate 30 at the time the successive recesses are passing the point or posi-

tion in front of the left-hand portion of the conveyor 56 adjacent the plate 30. The gear 62 is similarly synchronized with the operation of the motor 22 so that the successive pick-up hooks of the conveyor 60 have advanced through the corresponding successive recesses of the pick-up plate 30 passing the point or position in front of the right-hand portion of the conveyor 60 adjacent the plate 30. The purpose of this synchronized operation will later be explained. The synchronization itself may, of course, be effected in any desired way, as, for example, through a train of gears between the shaft of the motor 22 and the gears 58 and 62, schematically represented in FIG. 3 by the dotted lines S, but not shown in detail in view of the well-known character of the same and in order not to complicate the drawing so as to detract from the features of novelty of the invention.

It is believed conducive to clarity to describe the operation of the machine by tracing the passage of a fiber strand therethrough. Referring to FIG. 4, therefore, the pick-up plate 30 is shown disposed with the recess 31 adjacent the conveyor chain 56. The fiber strand 1 is, as before described, fed upward from the beam 14 through the aperture 72 in the reed 24. The reed 24 is preferably disposed close to the pick-up plate 30 and is preferably either of somewhat smaller diameter than the pick-up plate 30, or the apertures 72, 73, 75, etc. therein are displaced inward from the circumference of the reed 24, as illustrated, in order that the strand 1 may extend from the aperture 72 of the reed 24 at an outward incline upward to and through the guide 48 of the projection 41 adjacent the recess 31. The thread 1 is initially knotted or looped at 74 to the hook 64 that is passing vertically through the recess 31 as that recess is rotating horizontally past the conveyor 56. As a result of this inclined feed of the strand 1 from the aperture 72 to the projection 41, the strand 1 cannot be prematurely engaged by the next lower pick-up hook 68 of the conveyor 56. A similar result may be obtained with an annular or ring-like reed 24 of diameter preferably somewhat smaller than that of the pick-up plate 30 and through the inner surface of which the strands may be fed. The biased or inclined trapezoidal nature of the recess 31 and the projection 41, moreover, facilitates the movement of the pick-up hook 64 through the recess 31 as it draws the strand upward.

Strands from successive portions of the beams 14, 16, 18, etc. are similarly connected through successively disposed apertures in the reed 24 and corresponding successive projections on the pick-up plate 30 to the successively disposed pick-up hooks on the conveyor 56, as the pick-up plate 30 is rotated horizontally during the vertical movement of the conveyor 56. As is shown in FIG. 5, the successive strands, 2, 3, and 4 have been secured to the respective successively lower pick-up hooks 68, 79 and 81, after passing through the respective successive apertures 73, 75 and 77 in the reed 24 and the respective successive guides 50, 52 and 54 in the regions of the respective successive pick-up plate projections 42, 44 and 46 adjacent the respective recesses.

By the time the pick-up plate 30 has rotated through about one hundred eighty degrees to carry the first strand 1 and the corresponding recess 31 to a point substantially diametrically opposite the starting point of FIG. 4 and adjacent the conveyor chain 60, the pick-up hook 164, FIG. 6, mounted upon the link 166 of the chain 60, at before described, passes through the recess 31 in the plate 30. The hook 164 thereupon catches or picks up the strand 1 and draws or pulls it outwardly and upwardly during the continued upward movement of the conveyor 60. Successive pick-up hooks of the chain 60 will similarly successively catch or pick up the successive strands 2, 3, 4, etc. during continued horizontal rotation of the plate 30 and vertical movement of the chain 60. This continued horizontal rotation of the pick-up plate

30 with continued upward movement of the chain 60

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causes successive strands 1, 2, 3, 4, etc. to become oriented along diagonals reverse to their original orientation. Thus, in FIG. 3, the strands that are in the process of passing from the conveyor 56 toward the conveyor 60 in front of the plate 30, are oriented in the direction extending from the upper right-hand corner downward toward the lower left-hand corner, as illustrated by the strands 1, 2, 3, etc.; whereas, the strands that have passed by the conveyor 60 and are continuing along the rearward portion of the pick-up plate 30, back towards the conveyor 56, are oriented in the direction extending from the upper left-hand corner downward toward the lower right-hand corner, as illustrated by the strands 6, 7, 8, etc. By the time the pick-up plate 30 has made a complete revolution, therefore, there has been provided a forward partial substantially conical surface of strands bounded by the conveyor 56 and a line extending from the upper right-hand portion of the conveyor 56 downward toward the left-hand edge of the pick-up plate 30 and including strands 1, 2, 3, etc.; and there has also been produced a rearward partial substantially conical surface of strands bounded by the conveyor 60 and a line extending from the upper portion of the conveyor 60 downward toward the right-hand edge of the plate 30 and including strands 6, 7, 8, etc. As more particularly shown in FIG. 8, the rearward conical surface may make an angle θ with the plane of the base plate 30, such as the before-mentioned forty-five degrees, while the forward conical surface will make a corresponding angle with the plate 30 of substantially $180^\circ - \theta$, or substantially one hundred thirty-five degrees in the above illustration.

There are thus provided the two groups of fiber strands 1, 2, 3, etc. and 6, 7, 8, etc. that are now in juxtaposed planes and may be further operated upon to produce the fabric of the present invention. This may be accomplished by causing the conveyors 56 and 60 to carry the forward and rearward groups of fiber strands upward past a brush 13 which may be continuously impregnated with a flowing adhesive material fed from a conduit 15 and preferably of a quickly drying nature, such as a cement or plastic adhesive. The adhesive may also, of course, be applied in other ways to one or both groups of strands. The adhesively coated strands may then be fed further upward by the conveyors 56 and 60 to and between a pair of rolls 17 and 19, thus to laminate or press together the previously described forward group of threads 1, 2, 3, etc. with the rearward group of strands 6, 7, 8, etc. The groups of strands have thereby been formed into the material of FIGS. 1 and 2. The thusly fabricated material may be disengaged from the conveyor hooks by any desired mechanism such as, for example, the stationary cams 23 and 21, shown disposed on each side of the fabric and extending into the fabric to dislodge the successive strands of the fabric from the successive hooks of the upwardly moving conveyors 56 and 60. The completed fabric material may then be advanced over a delivery roll 25 for ultimate utilization. If it is not desired to maintain continuous production, the diagonally crossing groups of strands may be removed from the apparatus and laminated in separate presses or other equipment. Heat may also, if desired, be employed in the adhesion process.

Non-woven fabrics constructed in accordance with the present invention, in view of the freedom of the strands thereof from bends, may be as much as twenty to twenty-five percent stronger than similar woven fabrics, when employed as a reinforcement structure. As an illustration, successful non-woven fabrics have been made from fiber glass strands of about a fiftieth of an inch in cross-section, more or less, spaced apart about an eighth of an inch, more or less. In addition to achieving relatively low cost of manufacture and high production speeds, another advantage of the method and apparatus of the present invention resides in the fact that all of the strand ends are active at all times, as contrasted with the manufac-

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turing process of a woven fabric in which there is only one active yarn end, the woof, which is tossed back and forth in the shuttle. In manufacturing a woven fabric, moreover, with a high-speed loom operating at, say, 180 picks per minute, to produce an open mesh woven fabric with 10 picks per inch, the loom will produce 18 inches of fabric per minute, or 30 yards per hour. In accordance with the present invention, however, when the reed 24 operates at about 15 revolutions per minute, the amount of non-woven fabric, three feet wide and with the strands laid at about an angle of plus and minus 45 degrees, that can be produced in one minute is the same as the amount of woven fabric that can be produced by a loom in one hour, since one rotation of the pick-up plate 30 produces a length of fabric equal to twice the diameter of the plate.

The reed 24 is not always essential, though it is preferred for the apparatus previously described. If, for example, a group of strand-receiving guiding apertures are employed in each of the projections of a modified pick-up plate 30, the conveyors 56 and 60 may be elevated from the position illustrated in FIG. 3. The reed 24 may then be dispensed with, the pick-up process effected by the hooks carried by the conveyors occurring substantially near the bottom of the conveyors 56 and 60 adjacent the pick-up plate 30, as illustrated in FIG. 9. Thus the projection 41 of the plate 30 is shown provided with a group of, for example, three strand-receiving guiding apertures 48, 48' and 48''; the projection 42 is provided with a similar group of strand-receiving guiding apertures 50, 50' and 50''; and so on. The projections are preferably disposed at an acute angle α of, for example, about 30 degrees, to the radius of the pick-up plate 30 for a reason later explained. There will now be a group of three pick-up hooks associated with each corresponding group of the strand-receiving guiding apertures in each of the projections of the pick-up plate 30. Thus, in FIG. 9, a modified pivotal hook-carrying member 66 is shown provided with a group of three hooks 64, 64' and 64''; a similar lower hook-carrying pivotal member 70' is shown provided with a group of three hooks 74, 74' and 74''; and so on. As more particularly shown in successive FIGS. 10, 11 and 12, the successive hooks of each group of hooks will successively catch the successive strands fed through the successive strand-receiving guiding apertures of the group of apertures in each projection of the pick-up plate 30. In FIG. 10, the first hook 74 of the group of hooks 74, 74' and 74'', is shown engaging the strand 2 emerging from the strand-receiving guiding aperture 50. In FIG. 11, representing the next instant of time during which the plate 30 has slightly rotated, the second hook 74' of the group hooks 74, 74' and 74'' is shown engaging the next strand 2' emerging from the second strand-receiving guiding aperture 50'. In FIG. 12, representing an instant of time thereafter the third hook 74'' will engage the third strand 2'' emerging from the strand-receiving guiding aperture 50''. The reason for the inclination of the projections at the angle α will now be evident, since the three pick-up hooks of each group must successively pick up the successively disposed strands of each group of strands, as described. Similar operation will take place at the conveyor 60 which is shown modified with groups of hooks in the same fashion as the conveyor 56. The operation of this modified machine of FIGS. 9 to 12 will proceed as before described, providing, however, more strands to the inch than the machine of FIG. 3.

It is to be understood, however, that more or less than three strand-receiving apertures may be provided as may groups of more or less than three pick-up hooks. It is also to be understood that the system of FIG. 9, in which the hooks pick up the strands in substantially the plane of the pick-up plate 30, may also employ single strand-receiving guiding apertures in the projections of the pick-up plate 30, as in FIG. 3.

Further modifications will occur to those skilled in the art and all such are considered to fall within the spirit and scope of the invention as described in the appended claims.

What is claimed is:

1. A method of the character described that comprises rotating an array of strands disposed substantially to define a cylinder, hooking each individual strand of the array of strands as it successively rotates past a predetermined point of the said cylinder, drawing the successively hooked strands beyond the cylinder, hooking each individual strand of the array of strands as it successively rotates past a further point of the said cylinder disposed substantially diametrically opposite to the said predetermined point, drawing the thusly hooked strands beyond said cylinder, applying adhesive to the strands, and laminating together the strands beyond each of the said points.

2. Apparatus of the character described having, in combination, means for supplying strands substantially defining a cylinder extending in a predetermined direction, means for rotating the strands about the axis of said cylinder, a first plurality of successively disposed strand-hook means movable along the said direction and disposed successively to pass a predetermined point of the said cylinder, means operated synchronously with the rotating means for moving the hook means along the said direction in order that the successively disposed hook means may each pick up an individual strand of the array of strands as it successively rotates past the said predetermined point and may draw the successively picked-up strand along the said direction, a second plurality of successively disposed strand-hook means movable along the said direction past a further point of the said cylinder disposed substantially diametrically opposite to the said predetermined point, and means operated synchronously with the rotating means for moving the second plurality of pick-up means along the said direction in order that the second plurality of successively disposed hook means may each pick up an individual strand of the array of strands as it successively rotates past the further point and may draw the thusly picked-up strands along the said direction.

3. Apparatus of the character described having, in combination, means for supplying strands substantially defining a cylinder extending in a predetermined direction, means for rotating the strands about the axis of said cylinder, a first plurality of successively disposed strand-hook means movable along the said direction and disposed successively to pass a predetermined point of the said cylinder, means operated synchronously with the rotating means for moving the hook means along the said direction in order that the successively disposed hook means may each pick up an individual strand of the array of strands as it successively rotates past the said predetermined point and may draw the successively picked-up strand along the said direction, a second plurality of successively disposed strand-hook means movable along the said direction past a further point of the said cylinder disposed substantially diametrically opposite to the said predetermined point, means operated synchronously with the rotating means for moving the second plurality of hook means along the said direction in order that the second plurality of successively disposed hook means may each pick up an individual strand of the array of strands as it successively rotates past the further point and may draw the thusly picked-up strand along the said direction, means for supplying adhesive to the strands, and adhesion-providing pressure means for laminating and adhering together the strands drawn along the said direction beyond each of the said points.

4. Apparatus of the character described having, in combination, means for supplying strands substantially defining a cylinder extending in a predetermined direction, means for rotating the strands about the axis of said cylinder, a first plurality of successively disposed strand-hook

means movable along the said direction and disposed successively to pass a predetermined point of the said cylinder, means operated synchronously with the rotating means for moving the hook means along the said direction in order that the successively disposed hook means may each pick up an individual strand of the array of strands as it successively rotates past the said predetermined point and may draw the successively picked-up strand along the said direction, a second plurality of successively disposed strand-hook means movable along the said direction past a further point of the said cylinder disposed substantially diametrically opposite to the said predetermined point, means operated synchronously with the rotating means for moving the second plurality of hook means along the said direction in order that the second plurality of successively disposed hook means may each pick up an individual strand of the array of strands as it successively rotates past the further point and may draw the thusly picked-up strand along the said direction, means for applying adhesive to the strands, and means for laminating together the strands drawn along the said direction beyond each of the said points.

5. Apparatus of the character described having, in combination, a platform provided with means for supplying strands from which may be drawn an array of strands substantially defining a cylinder extending in a direction substantially normal to the platform, a pick-up plate disposed substantially parallel to the platform and peripherally provided with a plurality of strand-receiving guiding means separated from one another by recesses, the strands of the array of strands being adapted to be fed along the said direction from the strand-supplying means through the strand-receiving guiding means at regions thereof adjacent the corresponding recesses between the guiding means, driving means for rotating the platform and the pick-up plate, first and second conveying means disposed adjacent substantially diametrically opposite predetermined points of the hook plate and each provided with a plurality of pick-up means disposed successively along the conveyor, and means operated synchronously with the driving means for moving the conveyors along the said direction so that, as the successively disposed recesses of the pick-up plate are rotated past the respective predetermined points, the successive hook means of the respective conveyors may pass through the successive recesses in order to individually pick up at the said adjacent regions of the corresponding strand-receiving guiding means the successive strands of the array of strands, thereby to draw the same along the said direction away from the pick-up plate.

6. Apparatus of the character described having, in combination, a platform provided with means for supplying strands from which may be drawn an array of strands substantially defining a cylinder extending in a direction substantially normal to the platform, a pick-up plate disposed substantially parallel to the platform and peripherally provided with a plurality of strand-receiving guiding means separated from one another by recesses, the strands of the array of strands being adapted to be fed along the said direction from the strand-supplying means through the strand-receiving guiding means at regions thereof adjacent the corresponding recesses between the guiding means, driving means for rotating the platform and the pick-up plate, first and second conveying means disposed adjacent substantially diametrically opposite predetermined points of the pick-up plate and each provided with a plurality of hook means disposed successively along the conveyor, means operated synchronously with the driving means for moving the conveyors along the said direction so that, as the successively disposed recesses of the pick-up plate are rotated past the respective predetermined points, the successive hook means of the respective conveyors may pass through the successive recesses in order to individually pick up at the said adjacent regions of the corresponding strand-receiving guiding means the

successive strands of the array of strands, thereby to draw the same along the said direction away from the pick-up plate, means applying adhesive to the strands, and means for laminating together the strands drawn along the said direction beyond each of the said points.

7. Apparatus as claimed in claim 5 and in which further guiding means is provided for inclining outward the portions of the strands adjacent the pick-up plate.

8. Apparatus as claimed in claim 7 and in which the further guiding means comprises a reed.

9. Apparatus as claimed in claim 5 and in which the said recesses are bounded by edges of the strand-receiving guiding means inclined to the said direction.

10. Apparatus as claimed in claim 5 and in which the said conveyors are link chains and the said hooks are secured to the links.

11. Apparatus as claimed in claim 5 and in which the strand-receiving guiding means comprises projections each provided with a transverse guiding aperture for receiving one of the strands.

12. Apparatus of the character described that comprises means for rotating an array of strands disposed substantially to define a cylinder extending in a predetermined direction, hook means for individually picking up the successive strands of the array of strands as they successively rotate past a predetermined point of the said cylinder, means for drawing the successively picked-up strands along the said direction beyond the cylinder, hook means for individually picking up the successive strands of the array of strands as they successively rotate past a further point of the said cylinder disposed substantially diametrically opposite to the said predetermined point, and mechanical means for drawing the thusly picked-up strands along the said direction.

13. Apparatus of the character described that comprises means for rotating an array of strands disposed substantially to define a cylinder extending in a predetermined direction, hook means for individually picking up the successive strands of the array of strands as they successively rotate past a predetermined point of the said cylinder, means for drawing the successively picked-up strands along the said direction beyond the cylinder, hook means for

individually picking up the successive strands of the array of strands as they successively rotate past a further point of the said cylinder disposed substantially diametrically opposite to the said predetermined point, means for drawing the thusly picked-up strands along the said direction, means for supplying adhesive to the strands, and adhesion-producing pressure means for laminating and adhering together the strands drawn along the said direction beyond each of the said points.

14. Apparatus of the character described that comprises means for rotating an array of strands disposed substantially to define a cylinder extending in a predetermined direction, hook means for individually picking up the successive strands of the array of strands as they successively rotate past a predetermined point of the said cylinder, means for drawing the successively picked-up strands along the said direction beyond the cylinder, hook means for individually picking up the successive strands of the array of strands as they successively rotate past a further point of the said cylinder disposed substantially diametrically opposite to the said predetermined point, means for drawing the thusly picked-up strands along the said direction, means for supplying adhesive to the strands, and adhesion-producing pressure means for laminating together the strands drawn along the said direction beyond each of the said points.

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