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[54] FLUID-ENTANGLED NONWOVEN FABRIC  
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28/72.2, 161/72  
[51] Int. Cl. B32b 5/12  
[50] Field of Search 161/72, 80,  
142, 154, 169, 57, 78, 55; 28/72.2, 1.4; 19/161

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ABSTRACT: A nonwoven fabric comprising a plurality of layers of generally parallel fiber-containing strands, the strands of one of said layers being disposed at varying inclinations with respect to the strands of an adjacent layer along the length of the fabric, and the fibers of said strands being entangled with fibers of adjacent strands both in the same layer and in a different layer.



FIG. 1

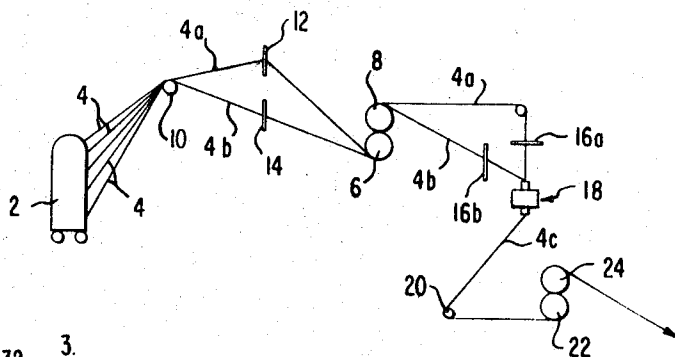


FIG. 2

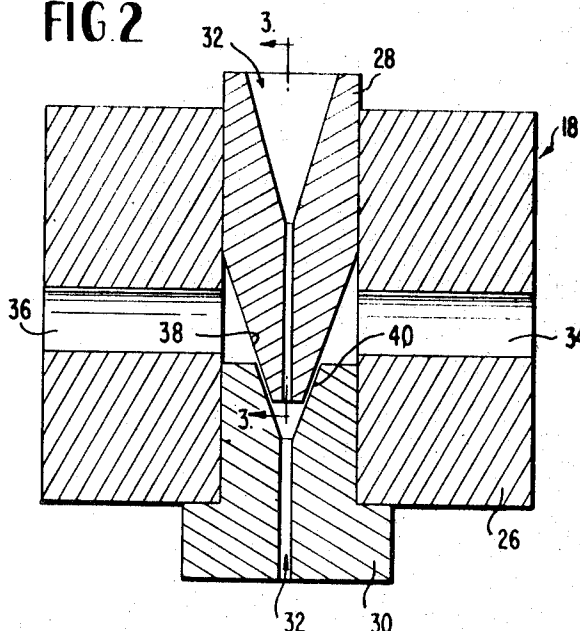


FIG. 3

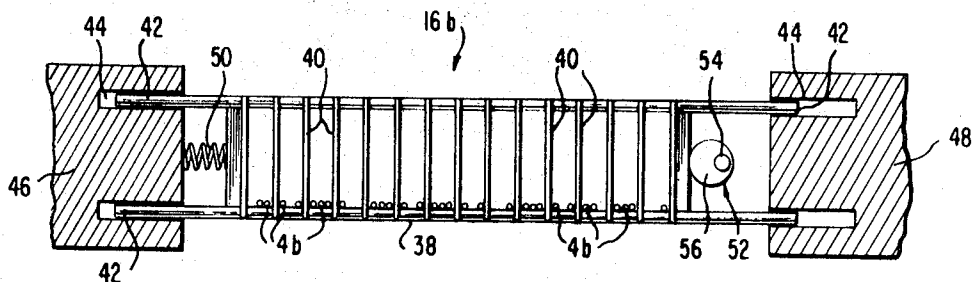
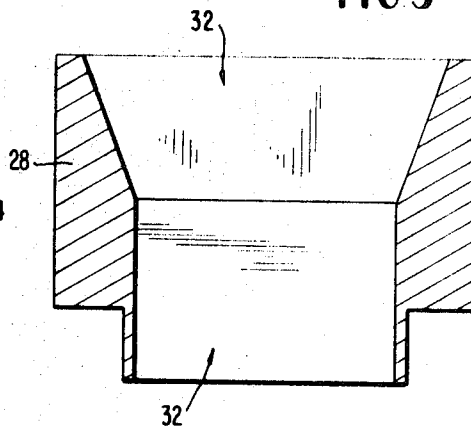


FIG. 4

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FIG. 5



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**FLUID-ENTANGLED NONWOVEN FABRIC**

This invention which is a divisional application of copending application, Ser. No. 516,858 filed Dec. 28, 1965 now U.S. Pat. No. 3,357,074, issued Dec. 12, 1967, relates to the manufacture of nonwoven fabrics.

It is concerned particularly with a method of and apparatus for manipulating fiber-containing strands so as to dispose the strands at varying inclinations with respect to the length of a sheet formed by entangling fibers of adjacent ones or groups of the strands. The novel fabric so produced has a number of advantageous characteristics.

Processes for obtaining nonwoven fabrics in the form of assemblies of entangled fibers have been known. A process of particular interest is disclosed in U.S. Pat. No. 3,055,080, granted to Claussen et al. on Sept. 25, 1962. In accordance with the disclosure of this patent, a plurality of yarns in the form of a flat sheet are fed continuously to fluid jet means having a slit-shaped nozzle. A jet of turbulent fiber plasticizing fluid acts upon the strands to crimp the individual fibers of the yarns and to entangle the fibers so as to form a cohesive sheet-like structure.

The present invention also is concerned with fluid entangling techniques for making nonwoven fabrics. It is an object of the invention to provide a method of and apparatus for improving the widthwise strength characteristics of fabric produced by fluid "weaving" or entangling processes. Another object of the invention is to provide a method and apparatus which may be used to achieve pattern effects in fluid-woven fabrics.

In accordance with an embodiment of the invention, a plurality of fiber-containing strands in sheet form are fed at a first rate toward fluid jet means and shifted back and forth laterally prior to their entrance into the fluid jet means to dispose the strands at varying angles with respect to the longitudinal axis of the fiber passageway through the fluid jet means. While the strands are within the fiber passageway of the fluid jet means they are contacted by a high-velocity fluid stream that serves to entangle fibers from adjacent strands in such a manner as to provide the sheet with structural integrity. The sheet is engaged by feeding means again after it leaves the fluid jet means, but the second feeding means operates to advance the sheet at a rate slower than that to which the strands were fed into the fluid jet means. That is to say, the linear rate of input is greater than the linear rate of output, so as to allow for the formation of loops in individual fibers and for inclination of the various strands relative to the lengthwise direction of the sheet.

It is contemplated that a plurality of groups of strands, each in sheet form, may be fed simultaneously to the fluid jet means. When this is done, it is preferred that the individual sheets be oscillated laterally out of phase with each other and that they enter the fluid jet means in generally superimposed relation. Fibers from the individual sheets become entangled not only with fibers from adjacent strands in the same sheet, but with fibers from strands in other sheets, producing a unitary assembly.

A more complete understanding of the invention may be gained from a consideration of the following detailed description, taken in connection with the accompanying drawings in which:

FIG. 1 is a diagrammatic view of an apparatus setup suitable for the practice of the invention;

FIG. 2 is a longitudinal cross-sectional view through a fluid jet structure of the type employed in the apparatus setup depicted in FIG. 1;

FIG. 3 is a transverse cross-sectional view taken along the line 3—3 in FIG. 2 and illustrating the entrance end portion of the fluid jet means;

FIG. 4 is an elevational view of an oscillatable reed construction suitable for use in the apparatus set up depicted in FIG. 1; and

FIG. 5 is a somewhat schematic view illustrating the appearance of the face of a fabric formed through the use of the apparatus setup of FIG. 1.

In FIG. 1, the reference numeral 2 designates a conventional strand supply, such as a creel or one or more warp beams. A plurality of fiber-containing strands 4, preferably in the form of zero twist yarns made up of continuous filaments, are withdrawn from the yarn supply 2 by feed means, here shown as a single pair of feed rolls 6 and 8. Normally, it will be found preferably to pass the strands 4 over a strand guiding and tensioning member 10 disposed between the strand supply 2 and the feed rolls 6 and 8. Also, it is desirable ordinarily to pass groups of the strands 4 through strand-separating means 12 and 14, such as reeds or eye boards, as the strands travel toward the feed rolls 6 and 8. The strands passing through the reed 12 have been designated 4a and the strands passing through the reed 14 have been designated 4b. If desired, separate sets of feed roll pairs may be provided for receiving the two groups 4a and 4b and these may be rotated at the same or different rates.

After being acted upon by the feed means, the strands of the group 4a pass through an oscillatable reed unit 16a and the strands of the group 4b pass through an oscillatable reed unit 16b. Either or both of the reed units 16a and 16b may be shifted back and forth in the widthwise direction of the advancing strands as the strands pass through the reeds.

The strands of groups 4a and 4b come together again at the entrance end of a fluid jet means 18. In this zone, the two strand groups will be in the form of superimposed sheets. They pass together in this form through the fluid jet means where they are acted upon by high-velocity fluid to entangle the fibers of the various strands and to produce a cohesive sheet or fabric structure. The fabric structure issuing from the fluid jet means has been designated 4c in FIG. 1.

The fabric 4c passes over guide means 20 and is fed away by feed rolls 22 and 24, the surface speed of which is substantially less than the surface speed of the input feed rolls 6 and 8. This difference in the linear rates of advance in the two parts of the system makes it possible for the fibers to assume angular positions with respect to the length of the fabric 4c. Individual fibers extend laterally in loop or crimp form to interlock with fibers from other strands, and the strands as such have wavy configurations along the length of the fabric 4c. The wavy configuration of the strands is suggested in FIG. 5. From this view, it will be observed that novel pattern effects have been achieved. Also, the lateral extend of the strands in various portions of the fabric serves to improve the widthwise strength characteristics of the fabric. The lateral spacing of the strands making up the fabric may be varied in order to produce different effects and structural properties. In the interests of clarity, the strands 4a and the strands 4b have been shown in FIG. 5 as being rather widely spaced apart in a lateral direction, but it will be understood that greater fiber densities are possible and often desirable.

The construction of the jet means 18 will be apparent from a consideration of FIGS. 2 and 3. The jet means illustrated in FIG. 2 is made up of a body 26, an inlet end unit 28, and an outlet end unit 30. A yarn passageway 32 formed internally of the units 28 and 30 is elongated in the transverse direction as suggested in FIG. 3 to permit the groups of strands 4a and 4b to remain generally in sheet form as they pass through the jet means 18.

Air or some other suitable fluid under pressure is introduced into the jet means through openings 34 and 36. The proximate surfaces 38 and 40 at the adjacent ends of the inlet and outlet units 28 and 30 are spaced apart from each other to permit the fluid to pass downwardly from the inlet ports 34 and 36 into contact with the fiber-containing strands and out the lower outlet end of the yarn passageway 32. The flow velocity of the air is high, and as a result the fibers making up the strands are looped and otherwise distorted to produce an entangling effect that gives the fabric the desired cohesive character.

Although the fluid flow through the outlet end of the strand passageway 32 has a component in the direction of the longitudinal axis of the strand passageway, the several strands

making up the groups 4a and 4b do not straighten under the influence of this flow. It has been found that the entanglement of the fibers is sufficient to lock the strands in angular positions corresponding generally to the angularity resulting from the lateral oscillations imparted to the strands by the reeds 16a and 16b just prior to their entrance into the strand passageway 32.

In connection with the oscillation of the strands back and forth in the widthwise direction, particular attention is invited to FIG. 4 of the drawings. In this view, a reed 16b, and means for oscillating it, are shown. The reed 16b is made up of a frame 38 carrying separator members 40 that serve to space individual ones or small groups of the strands 4b. In FIG. 4, varying numbers of strands 4b have been shown in the spaces between adjacent ones of the separator members 40 to indicate that the exact number is not a matter of critical importance. The frame 38 includes laterally extending end members 42 mounted for sliding movement 50 normally urges the reed 16b to the right as viewed in FIG. 4, but pattern means 52 may overcome the bias of the spring means 50 to move the reed 16b to the left.

The illustrated pattern means 52 is very simple in construction, being made up of a driven shaft 54 having mounted thereon an eccentric 56. As the shaft 54 is rotated, the eccentric 56 cams the reed 16b to the left and then recedes to allow the spring means 50 to shift the reed 16b to the right. Various forms of pattern means are known to the art, and it contemplated that the selection of particular pattern means will be based on structural considerations and also on the intricacy of the desired patterning. The details of the pattern means form

no part of the present invention.

The appearance effects achieved as a consequence of the wavy dispositions of the strands and the splayed arrangements of individual fibers in the fabrics produced in accordance with this invention may be varied somewhat through selection of various strand materials for use in the process. The strands may be in the form of tows, silvers, yarns or other assemblies, of either natural or synthetic fibers. The fibers and/or strands used in any given fabric may have the same or different color, luster, and/or denier characteristics.

Although a single embodiment of the invention has been illustrated in the drawings, it will be understood that this embodiment is exemplary only. It is intended that the scope of the invention be ascertained from the following claims.

1. A nonwoven fabric comprising a plurality of layers of generally parallel fiber-containing strands, the strands of one of said layers being disposed at varying inclinations with respect to the strands of the adjacent layer along the length of the fabric, the strands of each of said layers having wavy configurations along the length of the fabric with the waves of one layer being out of phase with the waves of an adjacent layer, the fibers of said strands having angular positions with respect to the length of said fabric, said fibers extending laterally in loop or crimp form and being entangled with fibers of adjacent strands both in the same layer and in a different layer.

2. A nonwoven fabric as defined in claim 1 wherein said strands are zero twist yarns of continuous filaments, the individual fibers of said strands interlocking with fibers from other strands.

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