

June 19, 1962

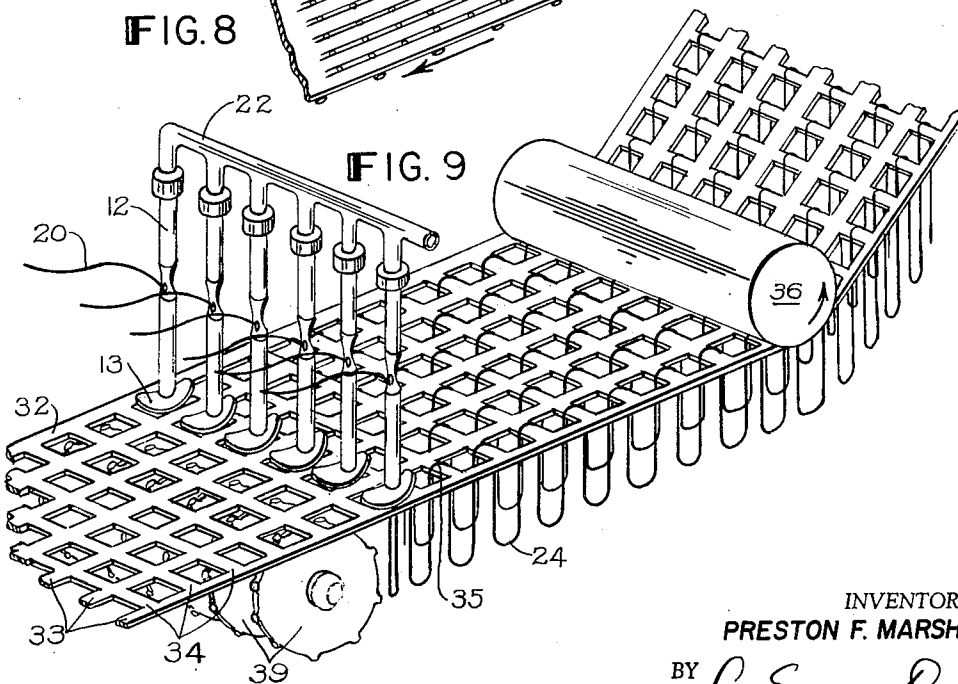
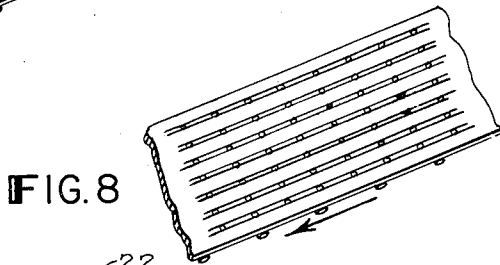
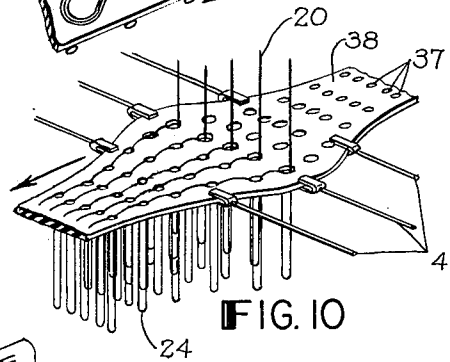
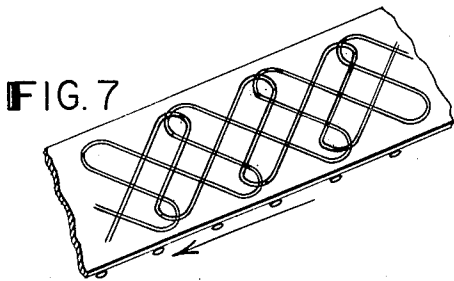
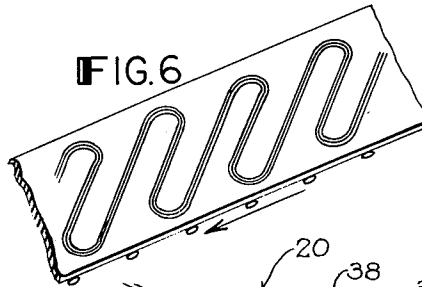
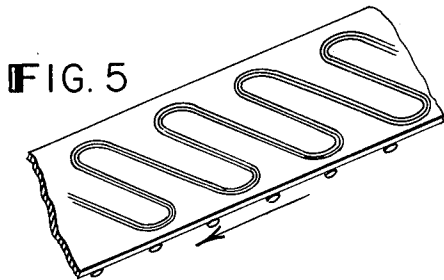
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3,039,170

APPARATUS FOR MAKING REINFORCED FABRICS AND THE LIKE

Filed Nov. 5, 1958

3 Sheets-Sheet 2



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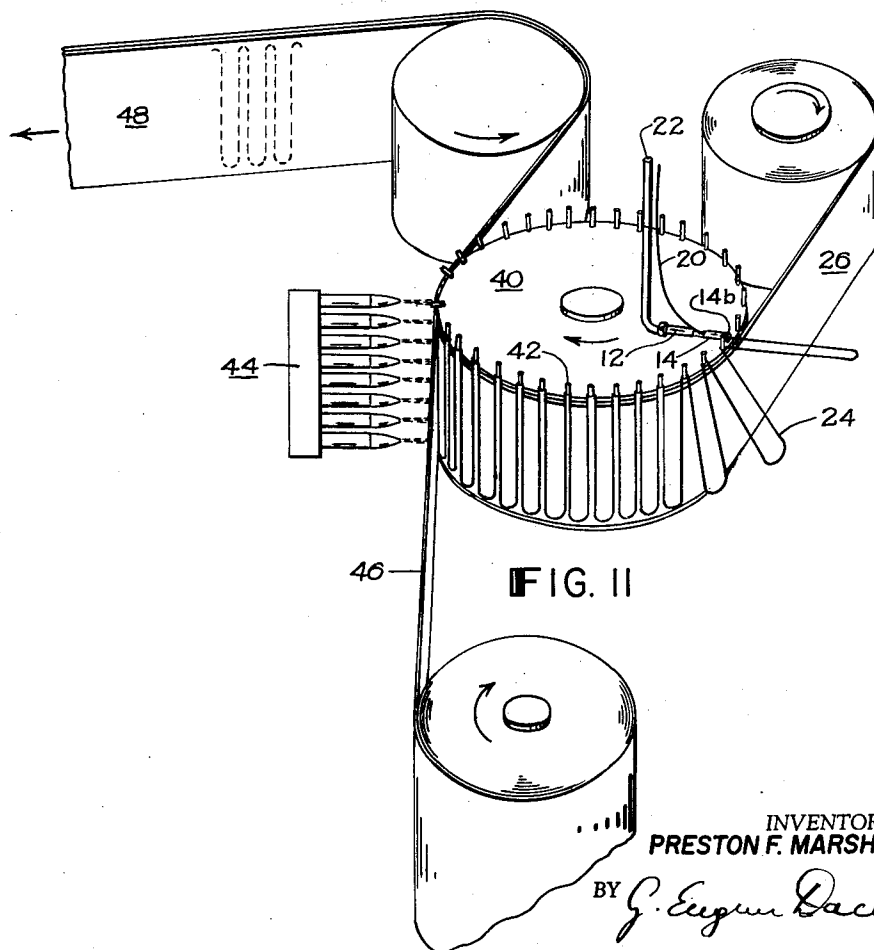
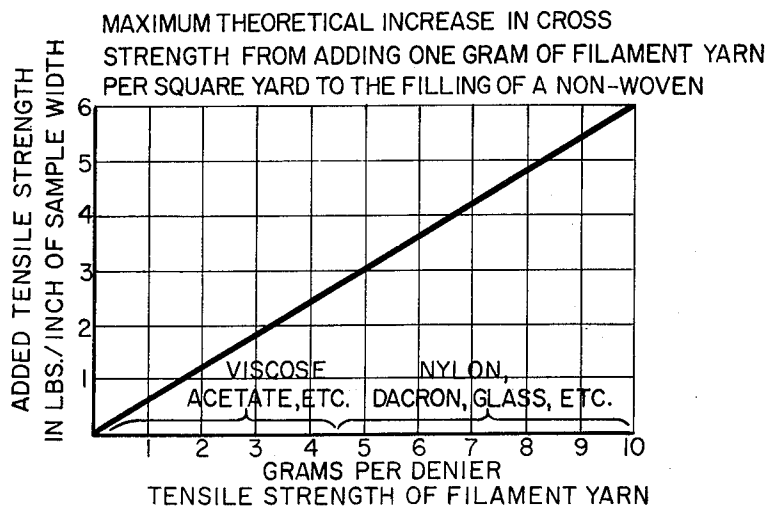
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3 Sheets-Sheet 3

FIG. 12



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3,039,170

APPARATUS FOR MAKING REINFORCED FABRICS AND THE LIKE

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4 Claims. (Cl. 28—1)

This invention relates to a method and apparatus for controlling the configuration of fluid-supported stream of filamentary material and depositing the controlled configurations of said filamentary material on a fabric to reinforce it and/or to enhance the decorative appearance thereof.

Reinforcement of fabrics, in particular of paper, by depositing yarns thereon is known in the art. Kelley, U.S. Patent No. 2,639,487, teaches the reinforcement of a sheet material by providing an air blower for delivering continuous strands of material, such as glass, onto a continuously moving sheet in such a manner that the strands will fall in random loop and swirl patterns thereon. This and other known methods, however, possess certain inherent disadvantages. By permitting the yarns to fall in uncontrolled and random swirls and loops on the fabric, the reinforcement of the fabric gained thereby will be nonuniform over the various parts of the fabric. Also, by following the teaching of Kelley or that of Anderson, U.S. Patent No. 2,622,306, the reinforcement will be primarily in the lengthwise or machine direction of the fabric. This aspect is particularly undesirable since most materials which need reinforcement, such as paper and non-woven fabrics, are known to possess far greater strength in the lengthwise than in the crosswise direction.

The development of a simple and inexpensive method for depositing a filamentary material, such as yarns and strands, on a continuously moving sheet material, in which the yarns or strands are deposited in substantially even and controlled patterns and in which the reinforced sheets have the desired physical properties represents a useful advance in the reinforcement art.

One object of the invention is the provision of a novel and improved method and apparatus for controlling the configurations of filamentary materials ejected from the apparatus by a fluid propellant means onto a moving fabric.

A further object is concerned with depositing tow or yarn or a combination thereof on a moving fabric, or between fabrics, sheets, films, webs, or fleeces, to provide added uniformly-distributed strength to such fabrics, in particular in a direction normal to the machine direction of such fabrics.

An additional object relates to enhancing the decorative appearance of such fabrics.

It is a further object to provide a novel method and apparatus for imparting a shuttleless pick motion to the fluid-propelled delivery of yarns at a delivery rate substantially faster than the rate that can be obtained using standard known practices, such as the flying shuttle or the mechanically-oscillating creel delivery.

It is still a further object to provide a novel method and apparatus for the fluid-propelled delivery of a multiplicity of identical or different yarns, strands, tapes, tow, roving or wire, into the same pick, accomplishing thus the effects obtained by the utilization of a box-loom.

Another object is to provide a novel method and apparatus for creating pile fabrics with unusual characteristics of loft and drape.

Still another object is to provide a novel method and apparatus for making pile fabrics that are independent

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of the use of needles, thus eliminating the troublesome problem of needle-breaking heretofore encountered.

The objects of the invention are, in general, attained by introducing a strand or a multiplicity of strands of filamentary material, such as tow, yarn, thread, cord, wire, strand, tape, roving or sliver, into a fluid-impelling device or chamber having an orifice, to one end of which device is connected a fluid-pressure source, causing said fluid-pressure to draw in the filamentary material into said device and, thereafter, to eject it through the orifice onto the moving fabric. The ejected strand of filamentary material is intermittently and with a periodic motion interrupted in its passage to the moving fabric by an interceptor moving in a plane normal to the axis of the ejected strand as the same leaves the orifice of the fluid-impelling device. As a consequence, the strand of filamentary material is deposited on the moving fabric in a controlled and predetermined pattern.

In one preferred embodiment of the invention, this interceptor comprises a folder bar mounted adjacent to one end of the impelling element. The folder bar is actuated in an inverted pendulum motion by a conventional driving means, such as a comb-box. In another preferred embodiment of the invention, the interceptor comprises the filling yarns of an open-mesh woven fabric, the fabric being moved in a plane normal to the plane of the axis of the yarn-impelling orifice or orifices and in close proximity therewith. In still another preferred embodiment of the invention, the interceptor comprises upright pins, collapsibly mounted on a drum-like frame, passing across the projected axis of the fluid-impelling element.

The details of my invention will be more clearly apparent and more readily understood by reference to the following detailed description when read in connection with the accompanying drawing, in which:

FIG. 1 is a perspective view of an apparatus constructed in accordance with my invention,

FIG. 2 is a sectional view of the constricted portion of the fluid-impelling element of the apparatus, as shown in FIG. 1, on an enlarged scale,

FIG. 3 is a diagrammatic view of my preferred process employing my apparatus shown in FIG. 1,

FIG. 4 is a perspective view of a modified apparatus constructed in accordance with my invention,

FIGS. 5, 6, 7 and 8 depict some of the various configurations of filamentary material as may be deposited on a fabric by the apparatus shown in FIGS. 1 and 4,

FIG. 9 is a perspective view of still another apparatus constructed in accordance with my invention.

FIG. 10 is a perspective view of a modification of a portion of the apparatus as shown in FIG. 9,

FIG. 11 is a perspective and diagrammatic view of still another apparatus constructed in accordance with my invention, and,

FIG. 12 is a chart showing the maximum theoretical increase in strength in non-woven materials that may be gained by utilizing filament yarns of various tensile strength.

Referring to the drawing, in particular to FIGS. 1 and 4, the reference numeral 10 designates the interceptor, herein shaped as a folder bar as more fully described below. The folder bar 10 is mounted in close proximity to the exit 14b of the orifice 14 which forms an integral part of the fluid-impelling device 12 and is joined therewith through a constricted portion 16. This fluid-impelling device 12 is a metallic tubular element whose walls are capable of withstanding an internal pressure of at least about 50 pounds per square inch. The orifice 14 is provided with an inlet 14a and an exit 14b. The inlet 14a, for best results, is positioned at a point where the orifice connects with the constricted portion. A hose

22 is conveniently attached to the other end of the device 12 for admitting therein the impelling fluid under pressure.

The fluid impelling device 12 may be of any known type or design, such as for instance the strand blower of Anderson, U.S. Patent No. 2,622,306. The folder bar 10 is preferably formed of three integral portions: a free-end portion 10a, an arcing portion 10b, and a vertical connecting portion 10c. The free-end portion 10a is the only portion of the folder bar 10 that has contact with and passes across the path of the ejected filamentary material as the same leaves the orifice 14 of the fluid-impelling device 12. The tip 10d at the bottom end of the free-end portion 10a lies in the projected axis of the driving shaft 18a of the driving mechanism 18. As a consequence, the tip 10d remains in the same position while the free-end portion 10a moves about said tip back and forth in a rotary motion through an arc of about 15° to 90°.

The arcing portion 10b joins the free-end portion 10a to the vertical connecting portion 10c. This arcing portion 10b lies and is adapted to move outside, and not below, the path of the ejected strand of filamentary material.

The vertical connecting portion 10c connects the arcing portion 10b to the driving shaft 18a of the driving mechanism 18. This mechanism 18 drives the interceptor (the folder bar) 10 back and forth as described above in a plane across the projected axis of said orifice and in close proximity to said orifice. This motion is referred to in this specification and the claims as an inverted pendulum motion.

The fluid-impelling chamber 12, as shown in FIG. 4, differs from the device 12 of FIG. 1 in that the forward part of said chamber 12 is cut off at the constricted portion 16 substantially where the inlet 14a was provided, said constricted portion forming thus outlet 16a for the chamber 12. In this modification, this constricted portion 16 performs also the function of the orifice 14 in combining the filamentary material 20 with the driving fluid, leaving the chamber 12 through the outlet 16a. In order to bring the filamentary material 20 into close alignment with this outlet 16a, two eyelets 17 are mounted on the chamber 12, one adjacent to said outlet 16a and the other somewhat spaced therefrom. A hose 22 connects to the other end of chamber 12 and is conveniently attached to any fluid pressure source denoted by "P" in FIG. 4. A connection may likewise be provided to a receptacle 30 collecting the ejected fluid from the chamber for re-use.

Filamentary material 20 may be conveniently stored next to the apparatus on supply reels or bobbins 20a substantially as shown in the drawings. In the apparatus, as shown in FIG. 1, this filamentary material 20 is fed into the orifice 14 through the inlet 14a. In the apparatus, as shown in FIG. 4, the filamentary material 20, instead of being admitted into the fluid-impelling chamber 12, is guided in close proximity to the outlet 16a of the chamber 12 through the previously described eyelets 17. Various fluids, such as hot or cold water, water vapor, and particularly gases such as air or steam, may be used as driving fluid, admitted in the device or chamber 12 via the hose 22.

The filamentary material may be yarn, tow, cord, thread, wire, strand, tape, roving or sliver, or any combination of these, and it may be elastic or inelastic.

The operation of my apparatus, as shown in FIGS. 1 through 3, is as follows. Filamentary material, unwinding from conventional bobbins and carried over conventional guiding units, is drawn into the orifice 14 through the inlet 14a by the suctional effect of the fluid pressure admitted into said device 12 via said hose 22. The drawn-in filamentary material is carried through the orifice 14 and ejected therefrom at a predetermined velocity through exit 14b. The velocity with which the filamen-

tary material leaves exit 14b depends on the one hand on the pressure admitted into the device 12 and, on the other hand, on the internal diameters of the device 12, the orifice 14, as well as the constricted portion 16. I prefer to employ a pressure from about 20 to about 40 lbs. per sq. inch. The preferred fluid is air at room temperature. The preferred internal diameter of the device 12 and of the orifice 14 is about 1/4 of an inch. The internal diameter of the constricted portion 16 is about 1/8 of an inch. The folder bar (interceptor) 10, adapted for movement in an inverted pendulum motion as previously described, intermittently and in a controlled, predetermined manner intercepts the path of the filamentary material 20 as it leaves exit 14b. As the path of the ejected yarn is intercepted by the folder bar 10, the bar, with its free-end portion 10a, frictionally engages the filamentary material, as at 35, forming thereby loops or folds 24 about said portions. These folds 24 are permitted gradually to slide down the free-end portion 10a and to fall off the tip 10d onto any moving medium, such as a fabric 26, carried by conveyor 28.

The length of these folds 24 may be varied by altering the fluid pressure admitted into the fluid-impelling device 12 and/or by altering the rate at which the interceptor 10 intercepts the path of the filamentary material. Increasing the rate of interception and/or decreasing the velocity of the strand at which it is ejected will decrease the length of the loops formed by said interceptor. Conversely, decreasing the rate of interception and/or increasing the velocity of the strand at which it is ejected will increase the length of the loops formed about said interceptor.

In the variation of my device, as shown in FIG. 4, the preferred fluid pressure is water at room temperature. After the filamentary material 20 is brought in close proximity to the constricted portion 16 via the eyelets 17, the emerging fluid carries along with it the filamentary material for a predetermined distance at a predetermined velocity. The length of the folds will again depend upon the pressure admitted into the fluid-impelling chamber 12, as well as upon the rate of motion of the interceptor 10. The ejected fluid is conventionally collected for re-use in a receptacle 30.

The steps in the process to reinforce and/or to enhance the decorative appearance of non-woven fabrics are illustrated diagrammatically in FIG. 3. Reading from right to left, a card deposits a carded web 26 on a conveyor 28. The apparatus of either FIG. 1 or FIG. 4 then deposits loops or folds 24 on the web 26 in controlled and substantially parallel loops thereon. A second card may be set up, depending upon the end product desired, to deposit a second carded web 27 on the web 26, but over the loops 24. The web or webs 26 and 27, together with the loops 24 of filamentary material, may then be immersed in a saturator containing any conventional binder, squeezed, and then dried. FIGS. 5 through 8 depict some of the several configurations of filamentary material as may be deposited on the moving fabric by the apparatus shown in FIGS. 1 and 4.

In FIGS. 5 through 7 the apparatus (not shown) is positioned at an angle to the direction of motion of the web so that the filamentary material is deposited thereon forming lines diagonally across the web. In FIG. 8, on the other hand, a series of apparatus (not shown) are set up above the web and with their exits pointed in the direction of flow of said web. The axes of the orifices (not shown) furthermore, are in parallel alignment with one another, as well as with the edges of the web. The configuration of the filamentary material deposited on the web will be in essentially parallel overlapping loops or folds running in the lengthwise or machine direction of the web. The number of these parallel overlapping loops or folds will be equal to the number of orifices employed, and the extent of overlapping of the loops in a given line

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will be determined by the speed of advance of the web and the frequency and length of loop formation.

In FIGS. 9 and 10 are shown two processes for the making of pile fabrics by the utilization of a series of fluid-impelling devices 12, having orifices 14, arranged in a plane perpendicular to the plane in which the woven fabric 32 is being moved. These orifices 14 are provided at their lower end with protective flanges 13. These flanges 13 serve the function of preventing the woven fabric 32 from getting caught in the orifices 14. A hose 22 is again conveniently attached to the upper ends of the fluid-impelling devices 12 for admitting therein the impelling fluid under pressure. The woven fabric 32, comprising warp yarns 33 and filling yarns 34, defining interstices thereamong, is carried by a series of guide rolls 39 underneath the orifices 14 and in close proximity to said flanges 13 in such a manner that each orifice is substantially at the center of the distance between two adjoining warp yarns 33. Filamentary material 20 is admitted into each of said orifices 14 and is ejected therefrom downwardly. The filling yarns pass at a predetermined speed underneath the orifices 14 and intermittently and regularly intercept the projected path of the filamentary material 20 as it leaves the orifices 14. At each of such interceptions, the material 20 is frictionally engaged, as at 35, about each filling yarn, forming loops thereabout. To secure the attachments of the loops to the woven fabric 32 in order that the length of the loops formed will remain substantially even, a coater roll 36 is provided to apply any conventional binder on the fabric 32, securing thus the attachment of the folds 24 to the fabric 32 at the points of their contact.

FIG. 10 represents a variation in the process of making pile fabric in that here the binding operation is omitted. Instead of utilizing a woven fabric, an elastic strip of material 38, having a series of apertures 37, is passed underneath the orifices 14, not shown in this figure. The elastic strip 38 is stretched sideways by hooks 41 and lengthwise by tension rolls, not shown, as it approaches the plane of the orifices 14, thereby enlarging the apertures 37. Filamentary material 20 is projected into these apertures forming loops thereabout. By permitting the contraction of the strip 38 and its apertures 37 now containing the loops 24, the loops are firmly held in place by the reduced diameter of the now contracted apertures 37.

FIG. 11 represents a modified apparatus constructed in accordance with my invention showing the various steps in diagrammatic form. The fluid-impelling device 12, as described with reference to FIG. 1 or the fluid-impelling chamber 12, as described with reference to FIG. 4, is arranged in combination with a drum-like frame structure 40 having upright pins 42 at its upper perimeter. These pins are collapsibly mounted on the frame 40, and they move in a circular motion about the perimeter. As the pins 42 move, they intercept one after another the path of the filamentary material as it leaves the stationary orifice 14 through its exit 14b. The frictionally engaged filamentary material 20 forms loops or folds 24 about the pins 42. These loops 24 are then permitted by the action of gravity to fall in parallel relation on a web 26 deposited about the vertical circumference of the drum-like frame 40 at a point just in front of the exit 14b of the orifice 14. A second web 46 may or may not be laid on the web 26, now having the loops 24 thereon, depending upon the end product desired. A series of spray-nozzles 44 is conventionally arranged at a point of about 180° from the exit 14b of the orifice 14. These nozzles spray conventional binder on the web, which when dried holds the loops firmly in place. As the web is moved about the vertical circumference of the frame 40, the pins 42 are permitted to collapse outwardly, thereby disengaging the folds 24. The composite web 48 may then be stripped off the circumference of the frame 40 and collected for further use or storage.

In FIG. 12 is shown a theoretical chart correlating the

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tensile strength of filament yarns employed to the gained tensile strength in sample width of the reinforced non-woven web. The abscissa marked from one to ten includes the most common tensile strengths of filament yarns while the ordinate marked from one to six represents the gained tensile strength in pounds per inch of sample width. The chart is to be read as follows: If one takes a filament yarn of, let us say, three grams per denier tensile strength and adds one gram of this filament yarn per square yard to the filling of a non-woven web, in theory one should have increased the tensile strength of the non-woven web by a maximum of about 1.8 pounds per inch of the width of the non-woven web. Now, if instead, one employs a higher tenacity filament yarn, such as nylon, of about seven grams per denier tensile strength and adds one gram thereof per square yard to the filling of a non-woven web, one should have increased in theory the tensile strength of the non-woven web. That is, by using the same one gram per square yard of a non-woven fabric, the increased tensile strength gained thereby will be directly proportional to the tenacity expressed in grams per denier tensile strength of the filament yarn employed. This maximum theoretical increase in strength is based on the assumption that the yarns are deposited on the non-woven web in regular even pattern normal to the machine direction of the web. The strength gained may, of course, be further increased by adding more grams of filament yarn to the same square yard of the non-woven web.

Some examples of the product of the invention are as follows:

Example 1

A carded web made of 1½ denier viscose staple fiber and having a weight of about 40 grams per square yard was reinforced with a continuous filament yarn of 600 denier viscose. The fluid-impelling apparatus was set up with its orifice normal to the directional movement of the carded web, substantially as shown in FIG. 1. The conveyor-belt speed was about 10 yards per minute, and the fluid-impelling device was so adjusted as to deposit about 420 loops of yarns per minute on the card. As each loop of yarn consists of two lines of yarn, this meant that there were about 840 lines of yarns deposited per minute. These loops, or lines of yarns, were deposited crosswise in a direction perpendicular to the lengthwise or machine direction of the carded web. There were about 2.33 lines of yarns per inch of the carded web. The deposition of the yarns added about six grams per square yard to the weight of the unbonded carded web. The composite structure was saturated with a latex binder and then dried. The weight of the resultant bonded, reinforced, non-woven fabric was 56 grams per square yard. A similar carded web was prepared without, however, being reinforced with a continuous filament yarn. The saturated weight of the non-reinforced carded web was 49 grams per square yard. A comparison between the crosswise strength of the reinforced and the non-reinforced non-woven fabrics showed that the yarn reinforced sample averaged about 2.2 times the crosswise tensile strengths of the non-reinforced non-woven fabric.

Example 2

A reinforced non-woven fabric was prepared as per sample one. Another sample of non-woven fabric was likewise prepared, but, instead of being reinforced with the 600 denier viscose yarns, it was reinforced with a filamentary glass yarn (Owens Corning D450 1/0 Z). Samples of these two fabrics were tested for elastic recovery after they had been put under strain. A one-inch wide test strip, cut crosswise, of each fabric was inserted in an Instron machine with a five-inch gauge length and a head speed of five inches per minute, imposing a strain of 20 percent. Upon release of the strain, the viscose reinforced sample recovered substantially its

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original dimension within about five minutes. The glass reinforced sample, on the other hand, could not even be subjected to the same strain of 20 percent and suffered visible ruptures of the yarns at 10 percent strain.

While I have disclosed my invention with particular reference to the various preferred embodiments shown in the figures, I do not intend to limit my invention to these examples shown. To a person skilled in the art, various other embodiments of my invention may become obvious.

Having thus disclosed my invention, I claim:

1. In combination with a fluid-operated strand-impelling device having a discharge orifice for propelling strand from said orifice, an interceptor bar mounted in close proximity to said orifice, said interceptor bar having a portion extending above said orifice and a portion positioned in the same horizontal plane of said orifice and a free end positioned below said orifice and means for oscillating the portion of said bar positioned above said orifice so that the portion of said bar being in the same horizontal plane of said orifice reciprocates in front of said orifice to interrupt a strand propelled from said orifice, the free end of said bar being relatively stationary

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during the reciprocation of the other portions to permit loops of strand to fall by gravity in serially controlled order from said free substantially stationary end.

2. The combination as set forth in claim 1 wherein the said strand-impelling device is liquid-operated.

3. The combination as set forth in claim 1 wherein the said strand-impelling device is gas-operated.

4. The combination as set forth in claim 1 wherein the said strand-impelling device is steam-operated.

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