Feb. 19, 1957 I. S. NESS ET AL 2,782,130

NON-WOVEN FABRIC

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Fig. 1.

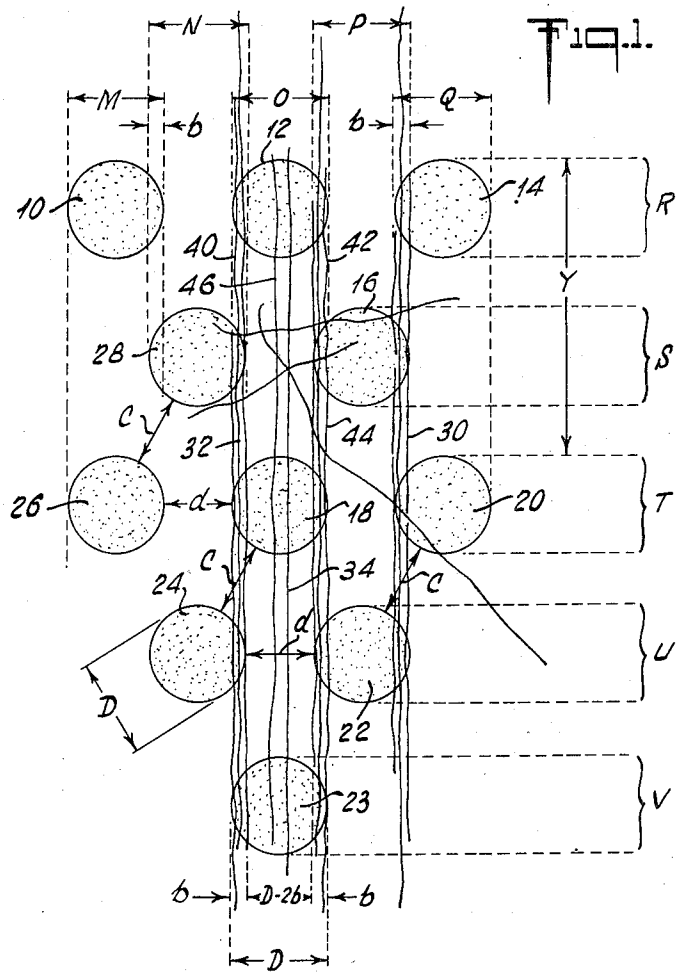
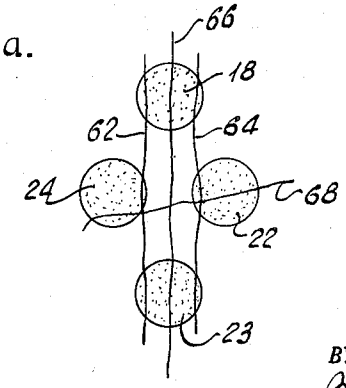


Fig. 1a.



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Fig. 2.

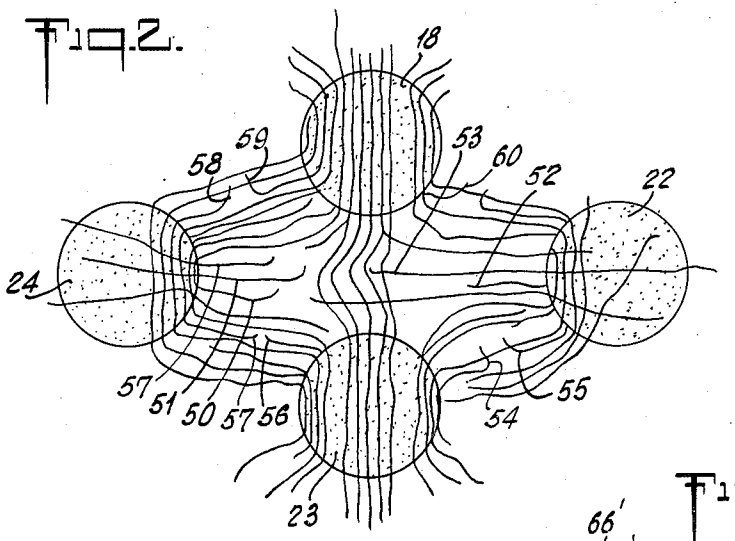


Fig. 2a.

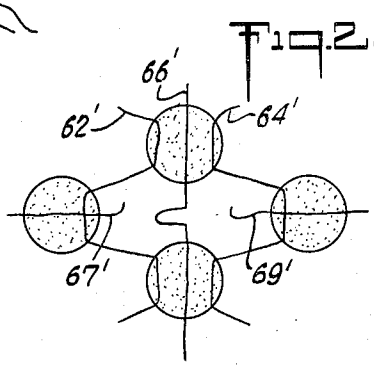


Fig. 3.

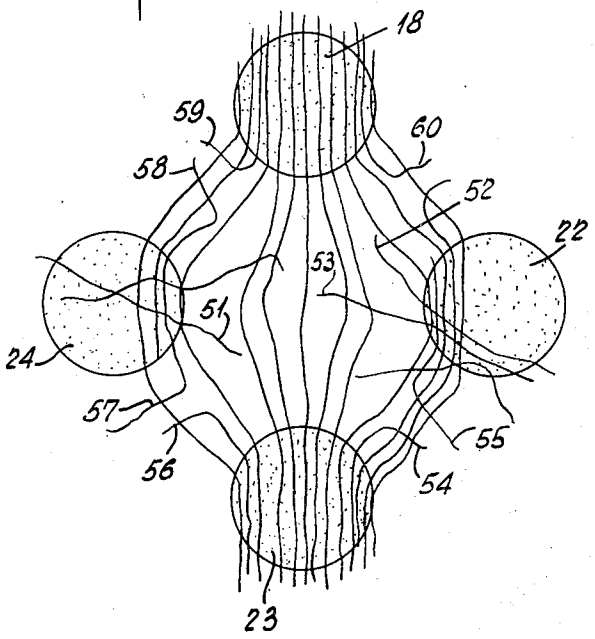
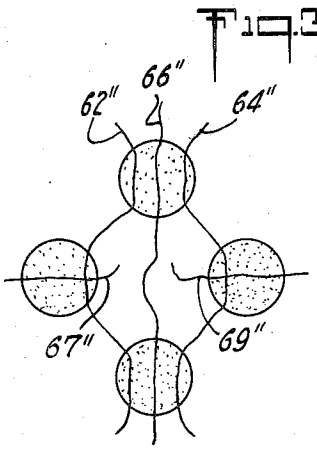


Fig. 3a.



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NON-WOVEN FABRIC

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Fig. 4.

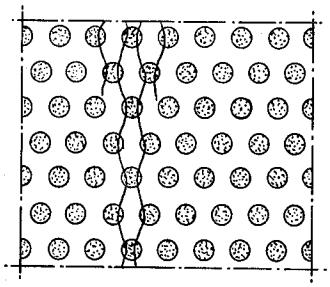


Fig. 5.

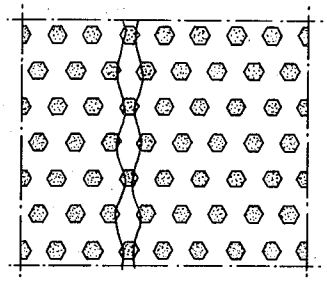


Fig. 6.

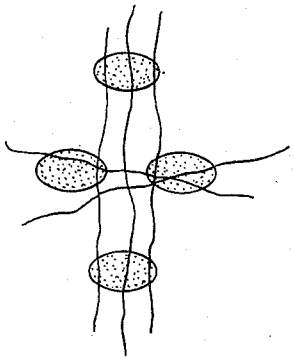
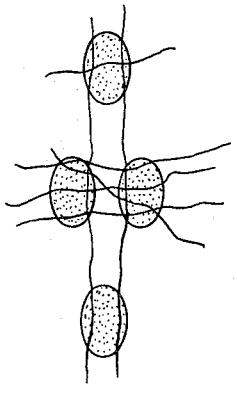


Fig. 7.



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2,782,130

NON-WOVEN FABRIC

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Application May 7, 1952, Serial No. 286,481

12 Claims. (Cl. 117—38)

The present invention relates to textile fabrics and their manufacture. More particularly, it is concerned with so-called "nonwoven" fabrics, i. e., fabrics produced from textile fibers without the use of conventional weaving or knitting operations. Although not necessarily limited thereto, the invention is of primary importance in connection with "oriented" nonwoven fabrics composed of unspun textile fibers, the major proportion of which are substantially "parallelized" or oriented predominantly in one direction.

Nonwoven fabrics of various types have become increasingly important in the textile field during the past decade, primarily because of their low cost of manufacture compared to fabrics formed by weaving or knitting spun fibers. Nonwoven fabrics are particularly suitable for applications where launder-ability is not a prerequisite, or low cost is an important consideration, especially in the case of finished products that are used once and then discarded, as for example in the manufacture of sanitary napkins; surgical dressings; casket liners; or disposable table napkins, hand towels, diapers, drapery fabrics, and the like.

Nonwoven fabrics are conventionally manufactured at the present time by producing a more or less tenuous web of loosely associated textile fibers disposed in sheet form (using any one of a variety of well-known procedures) and then subjecting the web or sheet to a bonding operation to anchor or bond the individual fibers together. The conventional base material for nonwoven fabrics is a web comprising any of the common textile-length fibers, or mixtures thereof, the fibers varying from approximately one-half inch to two inches in staple length. These fibers are customarily processed through anly suitable machinery (e. g., the conventional cotton card) to form a web or sheet of loosely associated fibers, weighing from 100 to 4000 grains per square yard. This essentially two-dimensional web or sheet of fibers is produced continuously with the fibers substantially parallelized or oriented in the "machine direction," i. e., the direction in which the product moves continuously from the sheet-forming machine. In such a web, the degree of fiber orientation may range from about 70% to about 90%; in other words, from about 10% to about 30% of the fibers will be "non-oriented" or more or less randomly disposed while the remainder will be substantially parallelized in the machine direction.

The bonding operation by which such a web is converted into a fabric is accomplished in several different ways. One method is to impregnate the web over its entire width with various well-known bonding agents such as natural or synthetic resins. Such over-all impregnation produces a product of good longitudinal and cross strength. However, the product tends to be stiff and boardlike, possessing more of the properties of paper or board than of a woven textile fabric: for these reasons, over-all impregnated webs are unsatisfactory for many applications as textile fabrics.

It has also been known to print nonwoven webs with continuous straight or wavy lines of binder extending transversely across the web. The resulting nonwoven fabric, as exemplified by the product disclosed in the Joshua Goldman Patent 2,039,312 and sold by the present assignee under the trademark "Masslinn," is far more satisfactory as a textile fabric in that the softness, drape and hand of the material more nearly approach those of a woven textile fabric. However, the Joshua Goldman type of product in the cross direction is characterized by relatively low elongation properties, low degree of elasticity, and a low energy absorption to break. For these reasons, the product upon stressing in a direction transverse to the direction of fiber orientation, tends to rip, tear or develop irregular holes due to irregular rupture of the continuous binder lines.

More recently discontinuous or "spot bonding" has been proposed. This type of bonding involves the use of tightly spaced, symmetrical solid dots or spots arranged in staggered relationship and covering more than half the total surface of the web, as exemplified by the product disclosed in the Esther Goldman Patent 2,545,952. Such "spot bonded" products are flexible when the fabric is folded upon itself. However, flexibility has been attained at the sacrifice of other desirable properties. Thus, the Esther Goldman type of product, although excellent in respect to cross strength, has little if any "give" or elasticity in the cross direction; practically no cross elongation characteristics; low energy absorption to break in the cross direction; and lacks the desired degree of textile properties of hand, loft and softness.

Generally speaking, the object of the present invention is to provide a nonwoven fabric that obviates the foregoing disadvantages. Expressed affirmatively, one of the objects of the invention is the provision of a nonwoven fabric characterized by the desirable properties of "spot bonded" fabrics but substantially free of the undesirable properties thereof.

A more specific object is the provision of a nonwoven fabric characterized by the following combination of properties:

1. High cross-elongation;
2. Good cross-strength;
3. Relatively high energy absorption to break in the cross-direction; and
4. Excellent textile-like properties such as softness or "hand," flexibility or "drape," and the three-dimensional appearance or "loft" characteristic of woven fabrics.

A further object is a nonwoven fabric that is additionally characterized by an inherent capacity to develop a more pronounced loft, softness and drape when stretched in the crosswise direction.

Another object is the provision of an oriented nonwoven fabric having a high capacity for fiber reorientation when stressed in the cross direction, with further improvement of its textile-like properties due to the development of a uniform puckering of some of the fibers coupled with a substantially uniform rupturing or pulling out of other fibers from the binder areas and the formation of a uniformly napped or downy-like surface.

Still another object is a nonwoven fabric characterized by a pronounced loft, drape and hand; a uniformly open, net- or lace-like reticular pattern, and a uniform downy-like surface.

Still another object is the provision of a novel binder pattern or design that is capable of imparting the foregoing properties to an unbonded oriented textile web.

An additional object is to provide a simple, commercially feasible, and economical method of manufacturing improved nonwoven fabrics having the properties mentioned above.

Other objects and advantages of the invention will become apparent as the description progresses in connection with the several figures of the drawing wherein:

Figs. 1 and 1–A are plan views, on an enlarged scale, diagrammatically showing relaxed portions of a nonwoven fabric having a binder pattern in accordance with one embodiment of the present invention;

Figs. 2 and 2–A are similar views, also on an enlarged scale, diagrammatically showing portions of the fabric of Figs. 1 and 1–A when uniformly stretched or extended beyond its elastic limit in a direction transverse to the direction of fiber orientation;

Figs. 3 and 3–A are similar views, also on an enlarged scale, diagrammatically showing portions of the fabric of Figs. 1 and 1–A, after the fabric has been uniformly stretched or extended beyond its elastic limit in a direction transverse to the direction of fiber orientation, and then permitetd to relax;

Fig. 4 is a plan view, approximately full scale, showing the geometry of the binder pattern involving disc-shaped binder areas in accordance with a preferred embodiment of the present invention;

Fig. 5 is a similar view, also approximately full scale, showing an alternative binder pattern involving hexagonal binder areas in accordance with another embodiment of the present invention;

Fig. 6 is a similar view, also approximately full scale, showing still another alternative involving oval-shaped binder areas in accordance with a further embodiment of the present invention, the minor axes of the ovals being parallel to the direction of fiber orientation; and

Fig. 7 is a similar view, also approximately full scale, showing a further modification involving oval-shaped discs disposed with their major axes parallel to the direction of fiber orientation.

In accordance with the present invention, a web of oriented textile fibers is bonded together by a novel binder pattern that may conveniently be characterized as "lazy tong," spot or multisegmental bonding wherein the binder pattern is composed of a multiplicity of discrete, physically separated spots or segments of binder infused locally into the body of the web, the spots or segments being "hinged," "jointed" or "articulated" with respect to each other and so related as to coact with the fibers on the "lazy tong" principle, giving the web a high degree of lateral extensibility.

As shown in Fig. 1, in spot bonding according to a preferred embodiment of the present invention, discrete, physically separated spots or segments of binder are utilized, each area preferably but not necessarily being substantially completely symmetrical; i. e., having a single point of symmetry.

The preferred binder pattern comprises a multiplicity of discrete, physically separated, disc-shaped binder areas **10, 12, 14, 16, 18, 20, 22, 23, 24, 26** and **28**, infused locally into the body of the web. In order to attain desirable textile-like properties and cross-extensibility on the lazy tongs principle the total lateral surface of the binder areas should not substantially exceed about 35% of the total lateral surface of the web.

The binder areas are uniformly disposed, preferably in parallel courses or rows R, S, T, U and V extending across the web in a direction preferably transverse to the direction of orientation of the fibers. The binder areas in one course (e. g., T) should be positioned in staggered relationship with respect to corresponding areas in the courses immediately above and below it (e. g., S and U) with more than an incidental overlap between each area in one row and the space separating the closest areas in the adjacent rows immediately above and below. The binder areas are so dimensioned and positioned relative to each other that every imaginary line parallel to the direction of fiber orientation passes through at least two isolated binder areas within a distance equal to the average length of the fibers composing the web, and in the area or zone

of overlap or "articulation," through at least three of the binder areas. This is most conveniently accomplished by disposing the binder areas not only in horizontal courses or rows (R, S, T, U and V) extending across the oriented fibers of the web, but also in a series of overlapping columns (M, N, O, P and Q) that are substantially parallel to the direction of fiber orientation. Such columns should have a width (D) equal to the transverse width (e. g., diameter) of each binder area, and should overlap more than incidentally, by a distance (*b*) equal to at least two hundredths (0.02) of an inch. Overlap (*b*) in excess of 0.05 has no appreciably beneficial effect on cross strength of the binder design.

By virtue of the foregoing interrelationship between binder areas and the base web, each binder area is separated from every other such area by fiber lengths that are otherwise substantially unbonded. Nevertheless, by virtue of the more than incidental overlap each annular area (e. g., **18**) is "hinged," "jointed," or "articulated" with respect to the two adjacent-most binder areas (e. g., **16** and **28, 22** and **24**) in each of the adjacent courses (e. g., S and U), i. e., in the courses immediately above and immediately below the area in question. "Articulation" between corresponding areas in adjacent courses is thus effected by bundles of parallelized, otherwise unbonded lengths of fibers in the zone of overlap, interconnecting the binder areas in question. Each bundle has a width approximately equal to the extent of the overlap (*b*) of the overlapping columns and is of the order of about 0.02 to about 0.05 of an inch.

The right hand side of any given binder area (e. g., **18**) will thus be "jointed" or "articulated" with the left hand sides of the closest areas (e. g., **16** and **22**) in the courses (S and U) immediately above and immediately below it. The "joint" or "articulation" consists of a bundle or band of fibers (e. g., **44**) about 0.02 to about 0.05 of an inch in width. On the left hand side of the given binder area (e. g., **18**) the relationship of the fibers to the given area and to the adjacent-most binder areas immediately above and below it will, in effect, be the mirror image or reflection of the relationship on the right hand side of the same area. In other words, a bundle of fibers (e. g., **32**) having a width equal to the extent of overlap (*b*) will interconnect the left side of the given area (**18**) with the right side of the two areas (**28** and **24**) immediately above and below it and closest to that side. The middle portion of the given binder area will be connected by a bundle of fibers (**46** and **34**) to the closest areas (**12** and **23**) in the second courses (R and V) above and below it. Thus, the third bundle (**46** and **34**) of parallelized fibers interconnects corresponding areas (**12** and **23**) in alternate courses (R and V), passing through the central portion of each binder area.

In order to understand the dynamics or kinematics of this binder arrangement, it is helpful to relate its action to that of a "parallel-motion mechanism" or "parallelogram-type device" familiar as "lazy tongs," "collapsible gates" or the "pantograph" device utilized in drafting. Referring to Fig. 1, in the web of the present invention the bundles of parallel fibers (e. g., **32, 40, 42** and **44**) interconnecting the binder areas (e. g., **12, 16, 18** and **28**) in three adjacent courses (R, S and T) may be likened to the linkages in a "lazy tong" parallelogram, while the binder areas (**12, 16, 18** and **28**) act, in effect, as the pivotal joints holding the links of the parallelogram together. The bundle of parallel fibers (**46**) interconnecting corresponding areas (**12** and **18**) in alternate courses (R and T) tends to pucker as the web is stretched in the cross direction. This puckering of fibers (**46**) connecting diagonally opposed points (**12** and **18**) in the parallelogram (**12, 16, 18** and **28**) tends to restrain further extension of the "pantograph" and to restore the extended "pantograph" to its original unextended position.

Regardless of the aptness of the analogy suggested

above, the individual binder areas are so positioned and interrelated as to interact or coact with the fibers of the web in a novel manner when the fabric is stressed in a crosswise direction. By virtue of this mode of interaction, an extraordinary combination of properties is attainable in the bonded web, including among other characteristics, high cross elongation coupled with good cross strength and high energy absorption to break. By virtue of the great proportion of lateral surface that is free of binder area, these properties are attained without sacrifice of textile-like properties such as hand, drape or loft. In addition, when the thus bonded web is stretched in the crosswise direction beyond its elastic limit, the web expands uniformly into an open, lacelike, reticular fabric.

An interesting and profound change in fiber orientation takes place as the web is extended. This change is diagrammatically shown in step-wise fashion in Figs. 1–A, 2–A and 3–A, which correspond to the state of the web in Figs. 1, 2 and 3, respectively. In Fig. 1–A, the bulk of the fibers are substantially parallelized or oriented, as represented by the lines **62**, **64** and **66**. In Fig. 2–A, the fiber **64'** tends to describe a sinuous, serpentine or zigzag pattern. Fiber **62'** is substantially its mirror image or reflection; and fiber **66'** between the binder areas is buckled up out of the plane of the binder areas. In other words, during extension some of the unbonded lengths of fiber (Figs. 2–A and 2–B; 3–A, **66'** and **66''**) between the discrete binder areas will "pucker" or bend out of the original plane of the fabric, forming a uniformly "puckered" or "quilted" appearance. Non-oriented fibers interconnecting the areas will be ruptured or pulled out of the binder areas during lateral elongation of the fabric. The ends of these broken fibers (Figs. 2 and 3; **51**, **52**, **53**, **54**, **55**, **56**, **57**, **58**, **59**, and **60**) tend to move out of the plane of the fabric, forming a uniform nap or down. The puckered fibers plus the downy nap both impart a high degree of loft and softness to the resultant fabric, rendering it especially attractive in applications where these properties are important.

Referring again to Figs. 1 and 2, the band of fibers in the overlap area *b* are of a strong, flexible nature, and are held together by the resin areas. Since the fiber band strength can be increased by increasing the extent of overlap *b*, the strength of the material will depend in part upon the degree of overlap (*b*). Within limits any factor tending to increase overlap will tend to increase cross strength. The degree of overlap (*b*) should not be less than about 0.02 of an inch and preferably should lie between 0.03 and 0.05 of an inch. The factors affecting cross strength comprise the interrelated variables Y and *b*, and the variable D.

The elongation of the fabric is influenced by the interbinder area distances D, Y and C. In general, the greater these distances, the greater the elongation. However, it is characteristic of spot bonding in accordance with the present invention to impart good cross elongation properties regardless of small changes in D, Y and C, provided the overlap *b* is sufficient and provided the total area of the binder areas does not substantially exceed about 35% of the total lateral surface of the web.

Energy absorption to rupture is indicative of the amount of work necessary to rupture the material and is approximately equal to one-half the breaking load times the elongation. In general, previous fabrics have been characterized by either high strength and low elongation, or low strength and high elongation. Both of these give relatively small and approximately equal work loads of energy absorption capacity. The present invention permits substantial increasing the work load by achieving a proper balance of cross strength and elongation. This property is controlled by the factors effecting the two properties discussed above.

Development of a uniform lace-like or reticular pattern obtained by uniformly stretching a web bonded in accordance with the invention is affected by the same factors mentioned in elongation, i. e., D, Y, and C. The uniformity depends upon the symmetry of the applied pattern, while D, Y and C determine the extent of openness, or lace-like structure: the more extendible, the more open the network.

The qualitative textile fabric properties of flexibility, drape, softness, and three-dimensional effect, or loft are enhanced by increasing the inter-resin area distances Y and C and decreasing the dimensions (D) of the resin areas. A basic factor in softness is of course the extent to which the lateral surface of the web is covered by binder. Generally speaking, desirable textile properties are attained to a substantial degree only if substantially less than 35% of the lateral surface of the web is bonded. With the present binder pattern the binder may be, and preferably is, used sparingly, with the bonded areas covering 5–25% of the total area of the web or sheet. The three-dimensional effect, or loft, is enhanced by the ability of the fabric to be extended crosswise with development of a uniform lace-like structure. The amount of loft, or three-dimensional effect is controlled by the shape of the reticular fabric structure which is, in turn, controlled by the "inter-island" distances (Y and C), by the overlap (*b*), and by the proportion of nonoriented fibers in the web.

Referring now to Figs. 4, 5, 6 and 7, these are plan views, roughly full scale, showing a portion of a typical "lazy tong" binder pattern in accordance with various embodiments of the invention. In Fig. 4, the binder areas are completely symmetrical discs while in Fig. 5 the binder areas are substantially symmetrical hexagonal shaped resin areas. In Figs. 6 and 7 the binder areas are elongated (e. g., oval-shaped, with a major and a minor axis. In Fig. 6, the major axes of the elongated areas are disposed transversely with respect to the direction of fiber orientation while in Fig. 7 the major axes are parallel to the fiber lay. However, in all instances, regardless of the geometry of the individual binder areas or "resin islands," they should be disposed in overlapping columns parallel to the fiber orientation, such columns overlapping to a more than incidental extent, i. e., by at least about 0.02 to about 0.05 of an inch. In addition, in all cases, the area of the web covered by binder should not substantially exceed about 35% of the total lateral surface of the web. The resulting fabric will exhibit high lateral extensibility on the lazy tongs principle. Furthermore, because of the more than incidental overlap mentioned above, the lazy tong binder pattern imparts excellent cross strength, cross elongation and cross elasticity to a web that originally was devoid of these properties, with minimal loss of the textile-like properties inherent in the base web from which the fabric is made.

In carrying the present invention into practice, any of the conventional web-forming, printing and drying operations, well known in the art, and any of the conventional binder media of the prior art may be used. Typical procedures and binder media applicable in the practice of the present invention include those disclosed in the Joshua Goldman Patent 2,039,312 or the Joseph Goldman Patent 2,407,548, or the Esther Goldman Patent 2,545,952. These operations and media, being well known and conventional, need not be described herein, since reference may readily be made to the prior art, including the patents mentioned. We prefer however to use an aqueous emulsion of polyvinyl acetate as the binder and to imprint the base web therewith using an engraved print roll of the intaglio type, the surface of the roll being engraved with a pattern such that when the binder emulsion carried in the binder-receiving recesses is transferred to the base web, it imprints thereon a binder pattern corresponding to any of those shown in the drawings or their equivalents.

The preferred base web consists of a card web of rayon fibers of two inches average staple length and so carded as to have, for example, 75%–85% of the fibers substantially aligned or oriented in the machine direction. In such a web, a substantial but nevertheless minor proportion (e. g., 15–25%) of the fibers will be "non-oriented" (i. e., more or less randomly arranged) although the major proportion (e. g., about 75% to 85%) of the fibers will be predominantly parallelized or oriented in the machine direction. Cotton fibers or any other textile fibers or mixtures thereof may of course be substituted for rayon staple.

The dimensions of the individual binder areas, and the "inter-island" distances C and Y (Fig. 1) may of course vary within wide limits. However, an illustrative fabric in accordance with a preferred embodiment of the present invention (corresponding to that shown in Fig. 4) may have the dimensions shown in Table I.

Table I

Example	D (In.)	Pattern Geometry, Dimensions		
		b (In.)	Y (In.)	C (In.)
A	0.095	0.02	0.31	0.075
B	0.135	0.04	0.38	0.075
C	0.16	0.04	0.44	0.09

Having now described the invention in specific detail and indicated the manner in which it may be carried into practice, it will be readily apparent to those skilled in the art that innumerable variations, applications, modifications and extensions of the basic principles involved may be made without departing from its spirit or scope. Thus the fabrics of the present invention may be laminated with other fabrics, with paper or with other materials, or employed in a host of ways that will be readily apparent to the skilled artisan. We therefore intend to be limited only in accordance with the appended patent claims.

The term "textile fibers" as used herein includes the conventional textile fibers which are capable of being spun into yarn and woven into cloth. Generally speaking this includes fibers whose average length is about one-half inch or longer.

We claim:

1. A web of carded fibers substantially all of whose fibers lying in parallelism are bonded together by a binder infused locally into the body of the web to form a binder pattern occupying from about 5 to about 35% of the total lateral surface of the web, said binder pattern comprising a series of parallel, uniformly spaced, broken lines of binder, each line in the series comprising substantially symmetrical areas of binder uniformly separated by spaces that are substantially free of binder, said parallel broken lines being inclined obliquely with respect to the direction of fiber alignment in the web; a second series of parallel, uniformly spaced broken lines of binder, each line in the second series likewise comprising substantially symmetrical areas of binder uniformly separated by spaces that are substantially free of binder, said second series of lines also being inclined obliquely with respect to direction of fiber alignment, but in the opposite sense or direction; said first series of parallel broken lines being so disposed with respect to said second series of parallel broken lines that the areas of one series lie in the intersegmental spaces of the other series and so that every straight line parallel to the direction of fiber alignment intersects at least two such areas within a distance in the direction of fiber orientation equal to the average length of the fibers composing the web whereby a band of fibers having a width of from about 0.02 to about 0.05 inch connects such areas.

2. The fabric of claim 1 wherein said binder areas have substantially a single plane of symmetry.

3. The fabric of claim 2 wherein said binder areas are substantially oval-shaped.

4. The fabric of claim 2 wherein said binder areas are substantially hexagonal.

5. The fabric of claim 1 wherein said binder areas have substantially a single point of symmetry.

6. The fabric of claim 5 wherein said binder areas are substantially disc-shaped.

7. A nonwoven fabric characterized by high energy absorption capacity when subjected to lateral stresses, said fabric comprising a web of textile fibers having a predominant fiber orientation direction and being composed of a major proportion of oriented fibers intermingled with a minor but substantial proportion of non-oriented fibers, the fibers of said web being bonded together by a discontinuous binder pattern comprising a multiplicity of discrete segments of adhesive binder infused into the body of the web but physically separated from each other by substantially unbonded areas of web, said segments being uniformly disposed in parallel spaced rows extending substantially normally to said predominant fiber orientation direction and also in parallel but overlapping columns extending substantially parallel to said predominant fiber orientation direction, the segments in any given row being in spaced but staggered and overlapping relationship with respect to the segments in the adjacent rows immediately above and below the given row, the overlapping columns having overlap zones of from about 0.02 to about 0.05 of an inch and providing bands of the same width composed of oriented unbonded fiber lengths, said bands interconnecting the binder segments into a lazy tong diamond structure whose diagonals are respectively substantially normal to and aligned with the predominant fiber orientation direction, said binder pattern being such that, within said overlap zone, every line parallel to said predominant fiber orientation direction passes through at least three binder segments within a distance along said line equal to the average staple length of the fibers composing the web, the aggregate surface covered by said binder segments being from about 5% to about 35% of the total lateral surface of said web, whereby said lazy tong diamond fabric structure is capable of undergoing substantial lateral expansion on the lazy tongs principle with the generation of a series of sinuous fiber bands arranged in opposed pairs and the formation of a soft, quilted, downy-like surface.

8. The fabric of claim 7 wherein said binder segments have substantially a single plane of symmetry.

9. The fabric of claim 8 wherein said binder segments are substantially oval-shaped.

10. The fabric of claim 8 wherein said binder segments are substantially hexagonal.

11. The fabric of claim 7 wherein said binder segments have substantially a single point of symmetry.

12. The fabric of claim 11 wherein said binder segments are substantially disc-shaped.

References Cited in the file of this patent

UNITED STATES PATENTS

1,507,949	Angier	Sept. 9, 1924
1,831,403	Woodward	Nov. 10, 1931
2,039,312	Goldman	May 5, 1936
2,407,548	Goldman	Sept. 10, 1946
2,498,197	Baxter	Feb. 21, 1950
2,545,952	Goldman	Mar. 20, 1951
2,550,686	Goldman	May 1, 1951

FOREIGN PATENTS

549,254	Great Britain	Nov. 12, 1942
500,020	Belgium	Dec. 30, 1950