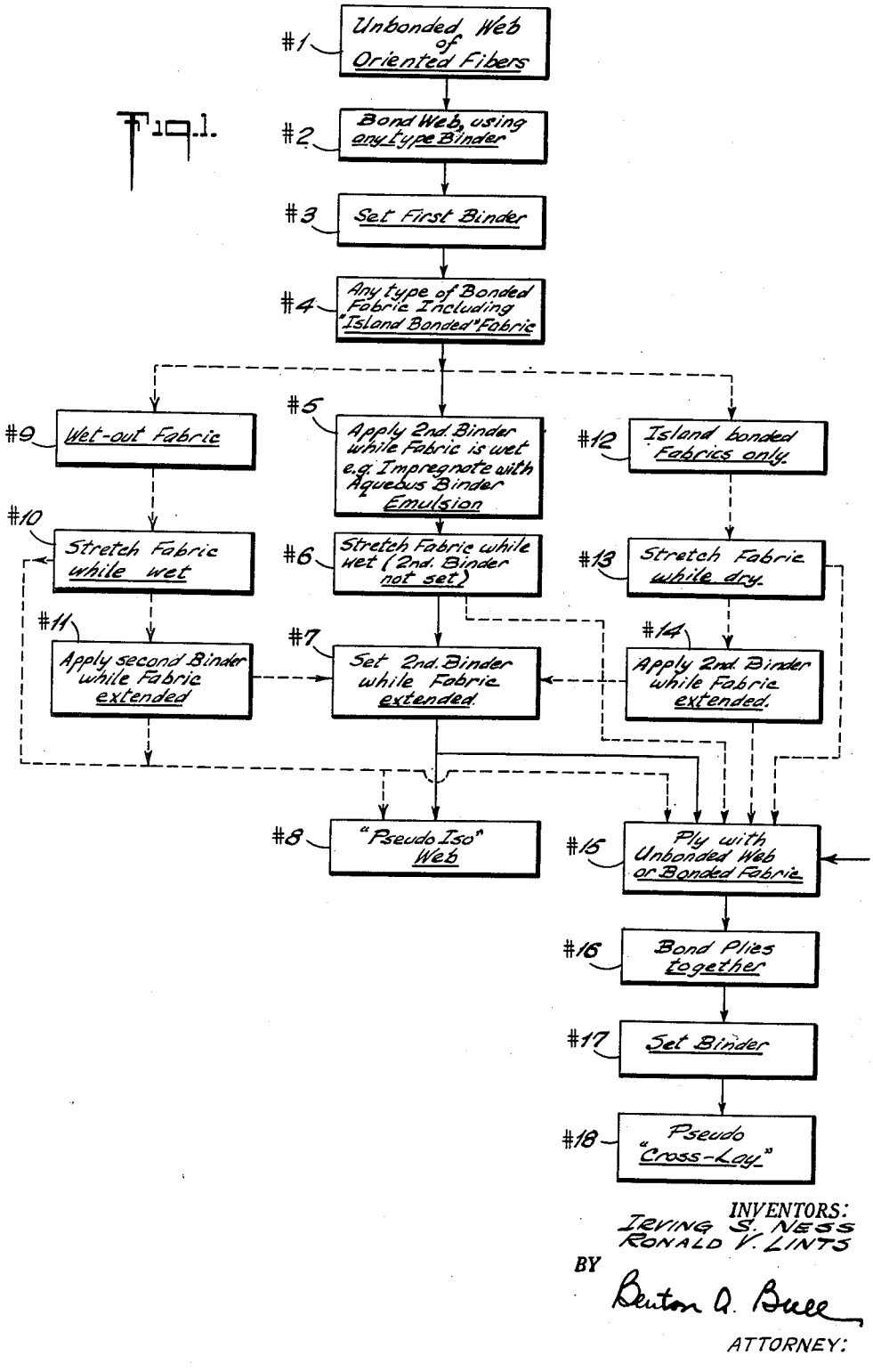
Dec. 21, 1954 I. S. NESS ET AL 2,697,678

FABRIC AND METHOD OF PRODUCING SAME

Filed April 7, 1952 5 Sheets-Sheet 1

Fig. 1.



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FABRIC AND METHOD OF PRODUCING SAME

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Fig. 2.

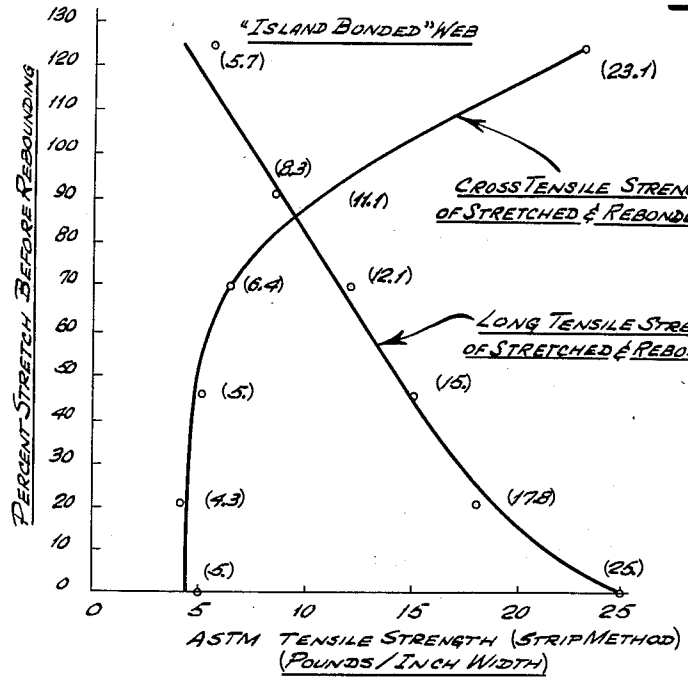
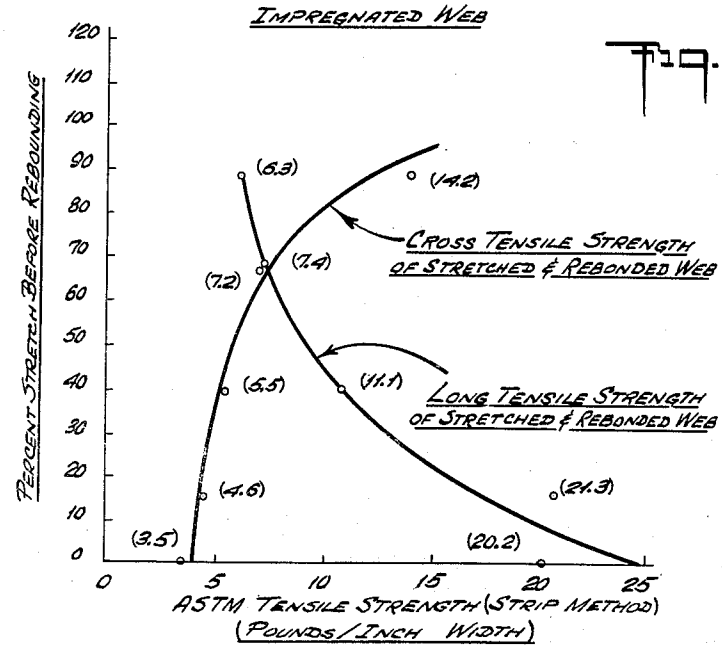


Fig. 3.



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Fig. 4.

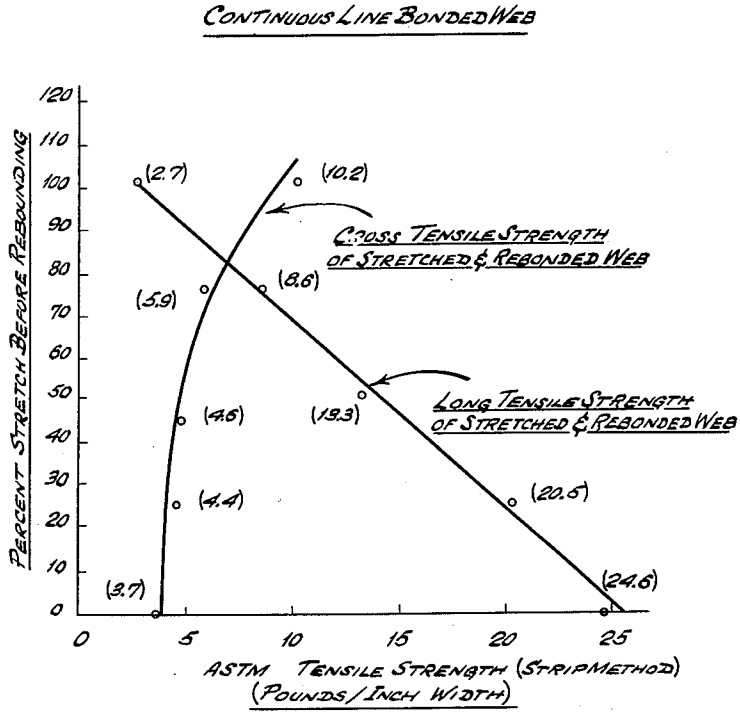
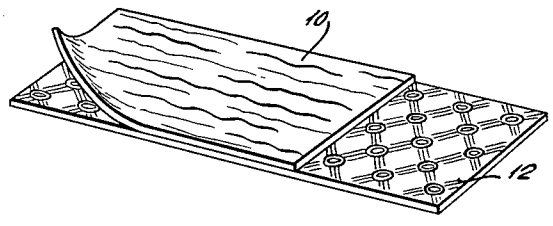


Fig. 5.



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Fig. 6.

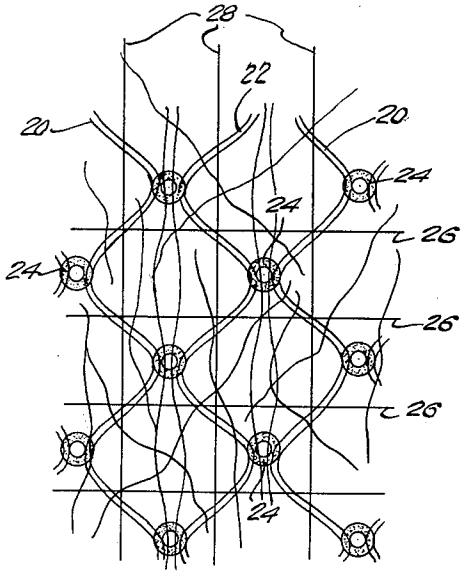


Fig. 7.

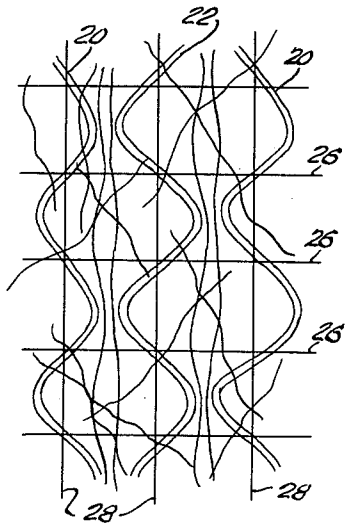


Fig. 8.

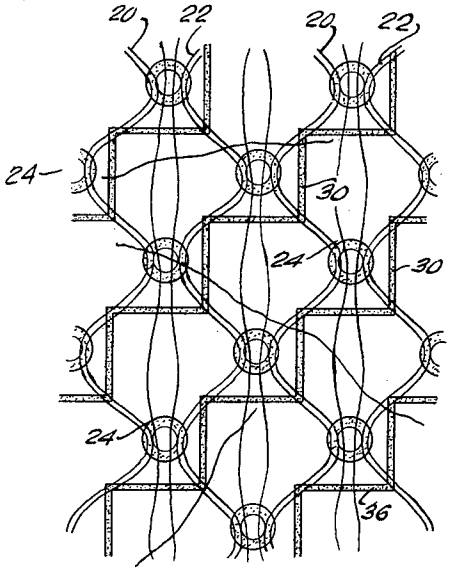
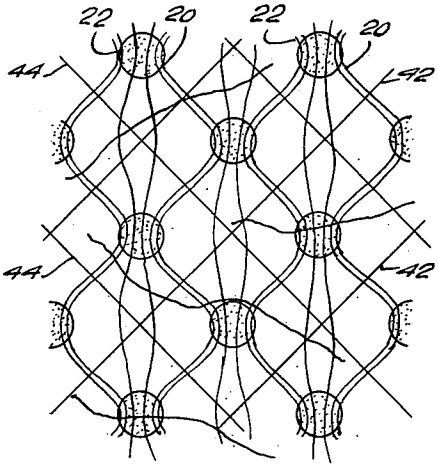


Fig. 9.



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Fig. 10.

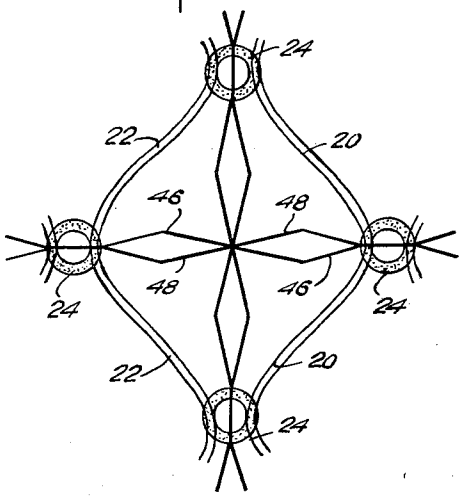


Fig. 11.

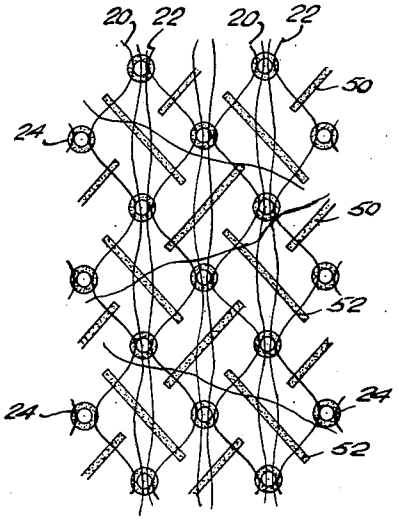


Fig. 12.

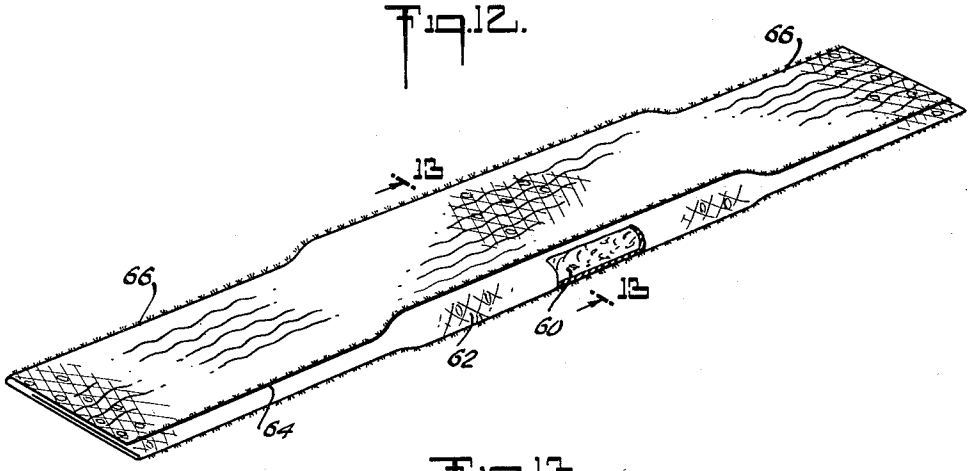
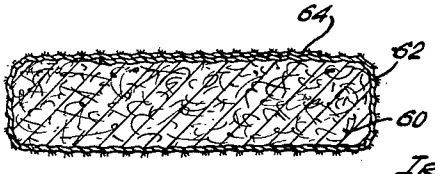


Fig. 13.



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FABRIC AND METHOD OF PRODUCING SAME

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Application April 7, 1952, Serial No. 280,966

30 Claims. (Cl. 154—101)

The present invention relates to textile fabrics and is more particularly concerned with so-called "nonwoven" fabrics, i. e., fabrics produced from textile fibers without the use of conventional weaving or knitting operations. The invention is of primary importance in connection with "oriented" nonwoven fabrics composed of unspun textile fibers, the major proportion of which are substantially oriented or predominantly "parallelized" in one direction.

Nonwoven fabrics are conventionally manufactured at the present time by producing a more or less continuous web of loosely associated textile fibers disposed in sheet form (using any one of a variety of well-known procedures) and then bonding the sheet or web 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 any suitable machinery (e. g., a conventional card) to form a web or sheet of loosely associated fibers weighing approximately 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., in 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 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 may be accomplished in any one of 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. Another method is to print nonwoven webs with continuous straight or wavy lines of binder extending transversely across the web. Still another method is to imprint on the web a discontinuous binder pattern, consisting of discrete, physically separated areas of binder, arranged in a staggered pattern.

Regardless of the bonding method used in producing a fabric from a web of oriented textile fibers, the fabrics of the prior art have been subject to several disadvantages. Of these disadvantages, one of the most outstanding is the fact that the web is "non-isotropic" in respect to its physical properties; the tensile strength of the fabric transverse to the direction of fiber orientation (i. e., its "cross strength"), is very much less than the tensile strength of the fabric in a direction parallel to the fiber orientation (i. e., its "long strength"). As a result, prior nonwoven fabrics have been characteristically weak in the cross direction, tending to rip or tear when the web is subjected to even a moderate extensional stress.

Generally speaking, one of the objects of the present invention is to provide a nonwoven fabric that is not subject to the foregoing disadvantage and which is characterized by a cross strength to long strength ratio of approximately one-to-one. In short, one of our objects is to produce a "pseudo-isotropic" non-woven fabric, i. e., one whose cross strength is substantially equal to its long strength.

Another object is the provision of a pseudo-isotropic nonwoven fabric, a substantial proportion of whose component fibers have been dimensionally stabilized or fixed in a reticular structure composed of a multiplicity of sinuous or serpentine bands of fibers arranged side by side in a common plane, each band being the substantial mirror image or "reflection" of the immediately adjacent band on either side.

A further object is a "pseudo cross-lay" laminated fabric, i. e., the product having physical properties typical of one formed by cross-laying and laminating two or more plies of oriented webs, but produced in accordance with the present invention without a true cross-laying operation.

Still another object is to provide a nonwoven substitute for woven gauze, consisting of a gauze-like nonwoven fabric having a uniformly open, lacelike, reticular structure that has been dimensionally stabilized sufficiently to resist deformation when stressed either crosswise or lengthwise of the web, the dimensional stabilization being effected without substantial impairment of the high porosity and absorptive capacity of the original web from which it was produced.

Another object is an absorbent dressing provided with a nonwoven, gauze-like cover sheet.

A further object is the provision of simple commercially feasible and economical methods by which the foregoing product may be produced from a non-isotropic web of substantially oriented textile fibers.

Still another object is to provide means by which the ratio of the long strength to cross strength of an oriented web of textile fibers may be varied within wide limits, and means by which the resulting product may be dimensionally stabilized to a predetermined degree, also within wide limits.

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

Fig. 1 is a flow sheet diagrammatically showing several processes by which the present invention may be carried into practice;

Fig. 2 is a graphical chart showing the change in physical properties of one form of bonded nonwoven fabric when processed to different degrees in accordance with the present invention;

Fig. 3 is a graphical chart showing the change in physical properties of another type of bonded nonwoven fabric when subjected to different degrees of processing in accordance with the present invention;

Fig. 4 is a graphical chart showing the change in physical properties of still another type of bonded nonwoven fabric when subjected in different degrees to the process of the present invention;

Fig. 5 is a perspective view of a laminated pseudo-cross lay fabric made in accordance with the invention;

Fig. 6 is a plan view, on an enlarged scale, of a fragment of one form of gauze-like nonwoven fabric in accordance with another aspect of the present invention;

Fig. 7 is a similar view of a gauze-like fabric made from the product of Fig. 6;

Fig. 8 is a similar view of a modified form of gauze-like product in accordance with the invention;

Fig. 9 is a similar view of a modified form of gauze-like product in accordance with the invention;

Fig. 10 is a similar view of still another modification of the gauze-like product of the present invention;

Fig. 11 is a similar view of a further modification of our gauze-like product;

Fig. 12 is a perspective view of a sanitary napkin in accordance with our invention; and

Fig. 13 is a section along the lines 12—12 of the napkin of Fig. 12.

In carrying our invention into practice, we start with a previously bonded web of oriented textile fibers, i. e., a "pre-bonded" oriented nonwoven fabric the binder of which is in a set or solidified condition. The weight of the original fabric, its binder pattern, and the type of operations subsequently performed on the starting material depend in part on the end product to be produced. Generally speaking, however, a basic operation used in producing therefrom all types of products in accordance with our invention involves stretching of the prebonded fabric in the cross direction while the binder is substantially in

its set condition. The stretching operation involves a deformation of the bonded web in the plane of the fabric, increasing its dimensions transverse to the predominant fiber direction and decreasing its dimensions parallel to the predominant fiber direction. The purpose of the stretching operation is to effect substantial reorientation of the fibers in the web, the type of reorientation accomplished depending in part on the character of the original pre-bonded fabric and in part on the manner in which, and degree to which, the fabric is stretched. In any event, after the "re-orientation stretching" is completed, the web in its extended state is rendered dimensionally stable by re-bonding in any manner that will satisfactorily "freeze," "anchor," or "fix" the fibers in their reoriented condition.

Referring now to Fig. 1, an unbonded web of oriented fibers such as that produced by a carding operation is subjected to any type of bonding operation to anchor the oriented fibers together. The resulting fabric with the binder set thereon is a bonded web of oriented textile fibers. These conventional operations, well known in the art, are indicated in Fig. 1 by the boxes identified as **1, 2, 3,** and **4**. So much was well known before the present invention.

Starting with such a pre-bonded web, several alternative methods of producing therefrom a "pseudo isotropic" web are available in accordance with one aspect of the present invention. One method which is universally applicable to all pre-bonded oriented webs, is to treat the web while the binder is set but the web is wet with a re-bonding agent (box **5**) and then stretch the web while the web is still wet but before the re-bonding material with which it has been treated is set, after which the web is subjected to any operation to set or solidify the re-bonding binder on the fabric in its extended state or condition (box **7**). The resulting fabric is our "pseudo-isotropic" fabric (box **8**).

One convenient method of carrying out the process described in the immediately preceding paragraph is to impregnate the pre-bonded web (box **4**) with an aqueous dispersion of binder (box **5**). Then while the web is still wet with the aqueous emulsion of binder, it is subjected uniformly to a stretching operation which increases its width by at least 50% and preferably 70% or more of its original width so that the width of the stretched web is about 150% to 170% of the width of the original web. The thus extended web is then subjected to a drying operation to set the re-bonding binder and thereby anchor the fibers in the deformed or stretched fabric to one another, in their reoriented condition.

A variation of the method described immediately above, also applicable to any type of bonded oriented fabric, is shown in boxes **9, 10,** and **11**. This optional or alternate method consists in first "wetting-out" the pre-bonded web by any convenient procedure, for example, by submerging the web in water (box **9**). After the wet-out, the wet web is subjected to a stretching operation to increase the cross dimensions of the web by at least 50% and preferably 70% or more (box **10**). The thus stretched web is treated with rebonding agent in any convenient manner, well known in the art (box **11**) and then treated (box **7**) in order to set the re-bonding binder. The resulting re-bonded fabric (box **8**) is also a "pseudo isotropic" fabric.

Still another optional or alternate route is shown in boxes **12, 13** and **14**. This optional route is of particular importance in the treatment of laterally extensible "island bonded" webs of oriented textile fibers, i. e., webs that have been bonded together into sheet form by a binder pattern covering only a minor portion of the lateral surface of the web and comprising a multiplicity of discrete, physically separated, but nevertheless "articulated" areas of binder arranged in a staggered pattern. Such webs are characterized by substantial capacity for extension in the cross direction, i. e., they may be stretched crosswise to substantial degree without rupture of the fabric, this being accompanied by a major reorientation of the fibers in the web. In such a web the individual binder areas may be any convenient form or shape, preferably one that is completely symmetrical, such as either a disc-shaped or a doughnut-shaped binder area.

One particularly satisfactory fabric of the above general type may be produced by imprinting on the oriented web an articulated, multiannulate binder pattern covering only a minor portion of the lateral surface of the web. The individual areas of binder are annular or doughnut shaped and are preferably arranged in parallel courses or rows extending transversely across the web and also preferably in staggered relationship, in overlapping columns that are parallel to each other and to the direction of fiber orientation, and overlapping each other to the extent of about 0.02 to about 0.05 of an inch. The annular areas are so dimensioned and positioned that every imaginary line within the overlap zone formed by the overlapping columns, and parallel to the direction of fiber orientation passes through at least three discrete binder areas within a distance along the axis of the imaginary line equal to the average length of the fibers comprising the web.

As mentioned before, in order to impart to such a web substantial capacity for lateral extension and also to preserve its textile-like properties, the binder pattern should cover only a minor proportion (e. g., about 10 to about 35%) of the total lateral surface of the web. Such a binder pattern coacts with the oriented fibers of the web on the well-known "lazy tongs" principle. Alternatively, but less satisfactorily, instead of employing annular binder areas, the binder areas may consist of spots or disc shaped areas arranged approximately in the same manner as the annular areas described above.

When a thus bonded web is stretched crosswise, it undergoes a lateral extension, with three highly significant results. In the first place a major re-orientation of the originally parallelized fibers takes place, with the development of a netlike or reticular structure due to the formation of a series of parallel, sinuous, or serpentine bands of fibers arranged side by side in a common plane and in apposition to each other, each band being the reflection or image of the two adjacent sinuous bands on either side. In the second place, the "collapse" of the binder pattern in one direction, which characteristically accompanies its extension in the cross direction, tends to buckle or pucker some of the originally oriented fibers out of the plane of the binder pattern with the development of a uniform quilt-like pattern of tiny "pillows" on the surface of the fabric. In the third place, a substantial proportion of the nonoriented fibers in the web, when subjected to tensional stresses as the web is extended crosswise, are either ruptured or pulled out of the binder areas. The thus released ends of the non-oriented fibers tend to bend out of the plane of the fabric proper, forming a uniform nap or down on the surface of the fabric. These three factors substantially improve the softness of the fabric when it is stretched crosswise beyond its elastic limit. However, the resulting fabric behaves as a "lazy tong" that has been partially extended: if the web is pulled in either direction, it tends to extend in that direction, and concurrently collapses in the opposite direction. Accordingly the web as such does not resist deformation in either direction: in short, it lacks "dimensional stability."

Starting with an island bonded web of the above type, in accordance with a further aspect of the present invention, the fabric is stretched while either wet or dry, the stretching being effected in the cross direction, until major reorientation of the fibers has been effected. The thus extended web is then re-bonded in any suitable manner to anchor the web in its extended condition. One convenient way of accomplishing this is to impregnate the stretched web with an aqueous emulsion of binder, the impregnation being carried out while the fabric is in the extended condition (box 14). The thus impregnated web is then dried (box 7) while the fabric is in its extended condition. The thus re-bonded web constitutes another "pseudo isotropic" fabric (box 8).

The effect of varying degrees of lateral stretch before rebonding is diagrammatically shown in Figs. 2, 3, and 4. In Fig. 2, the fabric starting material consisted of an "island bonded" web treated in accordance with the process as described in connection with Fig. 1, boxes 12, 13, 14, 7 and 8. The stretching process was interrupted at predetermined degrees of stretch, as indicated along the vertical axis (Figs. 2, 3 and 4) by "Per cent stretch before re-bonding." After the stretch was interrupted at these percentages, the re-bonding process was completed via an impregnation procedure, and the properties of the fabric finally determined. Depending upon the degree of stretch before the re-bonding operation, the long tensile strength of the finished fabric tends to fall off while the cross tensile strength tends to increase. If the fabric is subjected to a stretch of about 85% before re-bonding, the normal ratio of long-to-cross tensile

strength is reversed in the finished fabric. In other words, if the stretching operation before rebonding involves a stretch of greater than 80%, the finished fabric is stronger in the cross direction than in the long direction. Thus the long-versus-cross tensile strength relationship is reversed if the stretching before re-bonding exceeds about 80%.

Referring now to Fig. 3, this shows the relationship of cross tensile strength to long tensile strength of an overall impregnated web of oriented textile fibers treated in different degrees by the procedure described in connection with Fig. 1, boxes 5, 6, 7, and 8. As indicated in Fig. 3, at approximately 70% stretch, before re-bounding, a reversal in the normal cross-versus-long tensile strength is effected.

Fig. 4 shows the long tensile strength and cross tensile strength of a fabric treated to different degrees in accordance with the present invention, starting with an oriented web that has been pre-bonded by continuous lines extending transversely across the web. Here again the reversal in the normal long-versus-cross tensile strength relationship occurred when the per cent stretch before the re-bonding operation was approximately 80%. In other words, if the continuous line-bonded web is stretched to at least 180% of its original width, and then re-bonded, the normal relationship is reversed.

The data diagrammatically presented in Figs. 2, 3, and 4 were obtained in the following manner. The starting material consisted of an oriented web containing 100% bright viscose, the web weighing approximately 660 grains per square yard. This web was then bonded either by impregnation, "island bonding," or continuous line bonding, using the same binder (polyvinyl acetate) in all cases. In the case of the line and island bonded fabrics, the printing process followed in general the process disclosed in Joshua Goldman Patent No. 2,039,312.

The web bonded into a fabric as described above (i. e., with the binder set) was then treated by impregnation with an aqueous polyvinyl chloride emulsion containing approximately 35% solids. The fabrics were dipped in the emulsion and then separately stretched to a predetermined percentage of the original width. After the stretching operation, each impregnated web, while still wet, and still in its extended condition, was placed on a hot plate to dry the web and set the binder. The weight of the finished fabric was approximately 760 grains per square yard.

The pseudo-isotropic fabric prepared by any of the methods described above may be used in the production of a "pseudo-cross lay" laminated fabric. Referring to Fig. 1, boxes 15, 16, 17 and 18, the pseudo-cross lay process consists essentially in plying the "pseudo-isotropic" web (or one of its precursors products immediately following the stretching operation) either with an unbonded web of oriented fibers (box 1) or any other fabric, such as the bonded starting material (box 4). The laminated product may consist of two or more plies, involving one or more plies of the "pseudo-isotropic" web or its precursors. The laminated fabric is then bonded together in any suitable manner and the binder is set so that a laminated fabric is formed.

A typical pseudo-cross lay fabric, as shown in Fig. 5 may consist, for example, of an unbonded web **10** as one ply, and a pseudo-isotropic web **12** as the other ply. The "pseudo-cross lay" product can be obtained, if desired, in a continuous manner in the following fashion: The unbonded web (Fig. 1, box 1) is continuously subjected to the operations **2, 3, 4, 5, 6, 7,** and **8**. The resulting "pseudo-isotropic" web is then continuously plied with an unbonded web of oriented fibers constituting the starting material (box 1). The plying operation may be effected quite simply by continuously passing the plied webs between hot calender rolls heated to a temperature sufficient to soften the binder employed in making the component lamina.

As an example of the "pseudo cross-lay" product described above, a web of oriented textile fibers weighing approximately 660 grains per square yard was imprinted with the multiannular binder pattern. The bonded web was a fabric weighing approximately 750 grains per square yard. This fabric was dipped in the impregnating emulsion described above, the excess was then squeezed out, and the fabric was stretched 137% of its original width. The thus stretched fabric was dried in the extended condition and then plied with another portion of the original multiannular bonded material before it had been subjected to the stretching and impregnating operation. The plying operation was accomplished merely by passing the plies through hot calender rolls, steam heated to 250 to 300° F. The resulting two-ply fabric had a weight of 2560 grains per square yard; a long tensile strength of 24 pounds per inch width; and a cross tensile strength approximately the same.

Another aspect of our invention involves the production of a gauzelike product by a modification of the procedures described above. The starting material for a preferred type of gauzelike product consists of a lightweight annulate-bonded web weighing about 100 to 200 grains per square yard. When such lightweight fabric is stretched crosswise to a substantial degree, there is formed a uniformly open, lacelike, reticular product, which is highly porous and adsorptive. As a gauze substitute it is subject to the disadvantage that it is extensible in either direction, behaving in effect like a fishing net, on the "lazy tongs" principle. In other words, if the fabric is pulled in a direction that is either parallel or perpendicular to the axes of its sinuous bands, the fabric deforms. This dimensional instability of the product in either direction limits its usefulness as a gauze substitute.

In accordance with another aspect of our invention the dimensional instability of such a web may be overcome without substantially impairing its absorptive properties. One method of accomplishing this is to employ a rebonding binder pattern that covers only a minor proportion of the lateral surface of the web, but which is relatively inextensible in a direction either transverse to or parallel with the axes of the sinuous bands. One way of giving dimensional stability to such a web is to use either continuous or broken line bonding in the rebonding operation as shown, for example, in Figs. 6 to 11, inclusive.

In Fig. 6, the rebonding operation involves over-printing on the extended fabric a gridlike binder pattern consisting of two series of parallel, continuous and preferably fine lines of binder, one series being transverse to and the other series being parallel with, the sinuous bands comprising the web. The resulting fabric consists of a multiplicity of sinuous bands of fiber **20** and **22** arranged in opposed pairs that are the substantial reflection or mirror image of each other. The binder areas **24** originally holding said bands into a self-sustaining web are supplemented by a gridlike pattern formed by two series of parallel, continuous, fine lines of binder **26** and **28**. One of these series of parallel lines **26** extends continuously across the fabric, transversely with respect to the axes of said sinuous bands. The other series **28** of continuous fine lines of binder extends in the direction perpendicular to that of the first mentioned series **26**. The binding areas **24** of the original fabric preferably but not necessarily lie in the centers of the overlying grid pattern formed by the intersection of these two series of lines **26** and **28**. The resulting fabric has a uniformly varying fiber density which is highest at the locus of the sinuous bands **20** and lowest at the center of each square of the grid. This low density central portion lying in the centers of the grid pattern renders the resulting fabric pervious or porous and gives it its uniformly open, lacelike, reticular structure. The grid "overbinder" pattern imparts dimensional stability to the web without substantially impairing its absorptive capacity.

The binder material from which the original and second or rebonding binder patterns are prepared need not necessarily be identical. As a matter of fact, it is sometimes preferable to use different binders in the first and second bonding operations. For example, the original binder used for discontinuously bonding the original oriented web may consist of a water-soluble binder such as starch, polyvinyl alcohol, carboxymethylcellulose, or any well-known equivalent material. The second binder may consist of any of the water insoluble binder-media well known in the art, e. g., polyvinyl acetate, polyvinyl chloride, rubber latex or the like. In this case, after the second or rebonding operation, the original water-soluble binder areas (**24**, Fig. 6) may be removed from the fabric by immersing it in water long enough to dissolve the original binder. Such an expedient further improves the porosity and absorptive capacity of the resulting fabric, rendering it still more satisfactory for certain applications. The resultant fabric, diagrammatically shown in Fig. 7, is substantially identical with that shown in Fig.

6, except that the original binder areas (24, Fig. 6) have been removed.

An alternative rebonding binder pattern is shown diagrammatically in Fig. 8. In this instance, dimensional stability is imparted to the basic web by two series of zig-zag lines of binder, generally indicated by 30, both series extending obliquely across the fiber direction, but in opposite senses or direction. The segments comprising each zig-zag line in the series are long enough to interconnect corresponding points (34 and 36) on the opposed pairs of sinuous bands and corresponding points (34 and 38) on the ascending and descending sides of the nodes in each sinuous band. The resulting fabric has good dimensional stability, but a certain amount of "give" or elasticity in the cross and long directions.

Another alternative which also imparts a slight amount of "give" or elasticity in the cross and long direction is shown diagrammatically in Fig. 9. In this instance, the overprinted grid comprises a lattice-like or diamond-shaped pattern formed by two series of parallel, straight, fine lines of binder (42 and 44), each series being inclined with respect to the axes of the sinuous bands but in opposite senses or directions.

Still another means of imparting dimensional stability, but a slight amount of "give" or elasticity to the web is shown in Fig. 10. In this case, the overprinted, stabilizing binder lines 46 and 48 form "double diamonds" extending generally across the two axes of each of the "parallelograms" formed by opposed sinuous bands of fibers. Thus the "lazy tong" action of the original fabric is restrained by the "lazy tong" action of the stabilizing binder, acting in a reverse sense with respect to the action of the first "lazy tong." As one "lazy tong" opens, the other collapses, and vice versa.

Still another stabilizing arrangement which imparts a degree of springlike recovery action to the base fabric is diagrammatically shown in Fig. 11. In this instance, the stabilizing binder pattern is formed by two series of parallel, broken lines of binder generally indicated as 50 and 52, extending obliquely across the web at approximately the same angle, but in the opposite senses or directions. The elongated areas or segments of one series 50 lie in the intersegmental spaces of the other series 52. Each segment is long enough to interconnect opposite sides of the "parallelogram" formed by two opposed nodes of the pair of sinuous bands 20 and 22.

One application of the fabric produced as described in connection with Figs. 6 to 11 is in the production of absorbent dressings. Figs. 12 and 13 illustrate this type application in connection with a catamenial device of the "sanitary napkin" type. Referring to Figs. 12 and 13, any suitable absorbent core 60 is surrounded by a cover 62 folded about the core and usually overlapped as indicated at 64. The core may be made of any known and suitable material, such as cotton fibers, paper, fluffed paper pulp, and the like. The sheet material used for the cover comprises any of the fabrics described above in connection with Figs. 6 to 11, preferably when made from lightweight oriented webs weighing from 100 to 200 grains per square yard. For illustrative purpose, we have diagrammatically shown a napkin covered with the product described in connection with Fig. 9. In such an application of our fabric, the overgrid stabilized binder pattern gives the cover a desirable degree of dimentional stability when the tabs 66 are under tensional stress in use.

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.

Having now described the invention in specific detail and exemplified the manner in which it may be carried into practice, it will be readily apparent to those skilled in the art that innumerable variations, amplifications, modifications, and extensions of the basic principles involved may be made without departing from its spirit or scope. For example, although we have illustrated one application of the invention in the preparation of a sanitary napkin, it will be apparent that various types of fabric produced as herein described may be made from webs ranging from lightweight webs (e. g., 100 to 500 grains per square yard) all the way to heavy weight webs (e. g., 500 to 5000 grains per square yard). The resulting fabrics may be used in the manufacture of various types of surgical, medical, and first aid dressings and related supplies from the lightweight, gauzelike fabrics in accordance with our invention or in the manufacture of industrial fabrics, such as artificial leather, from the heavier fabrics. As another example of a modification, the first or the second bonding operations, or both, may be carried out by "hot printing" a thermoplastic binder, as shown in the Esther Goldman Patent 2,545,952; or either or both bonding operations may be effected by "wet printing" as shown in the Joshua Goldman Patent 2,039,312. In some instances it may be preferable first to "hot print," cool to set the binder, then stretch, and finally re-bond by the "wet print" technique. This modification eliminates the need for twice evaporating water from the web, as would be necessary if wet-printing were employed in the first bonding operations and stretching were thereafter carried out with the web in the wet condition. These and many other modifications will be readily apparent to those skilled in the art. 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 method which comprises stretching an oriented web of textile fibers united into a self-sustaining sheet by a binder infused into the web, the stretching being carried out while the binder is set and in a direction normal to the direction of orientation of said fibers; and then rebonding the web in its extended state.

2. A method of treating a nonwoven fabric prepared by bonding a web of fibers predominantly aligned in one direction, which comprises deforming the pre-bonded fabric in the plane of the fabric by increasing its dimensions transverse to the predominant fiber direction and decreasing its dimensions parallel to the predominant fiber direction, the deforming operation being carried out while the binder is set; and then adhesively anchoring the fibers in the deformed fabric to one another.

3. A method of treating a nonwoven fabric prepared by bonding a web of fibers predominantly aligned in one direction, which comprises deforming the pre-bonded fabric in the plane of the fabric by increasing its dimensions transverse to the predominant fiber direction and decreasing its dimensions parallel to the predominant fiber direction, the fabric density in weight per square unit of area remaining substantially constant; applying a potential rebonding composition to the deformed fabric; and developing the bonding properties of the rebonding composition to anchor the fibers of said fabric to one another.

4. A method which includes providing a web comprising a major proportion of oriented textile fibers and a minor proportion of non-oriented textile fibers, said fibers being united into a self-sustaining sheet by a binder infused into at least a portion of the lateral surface of said web; stretching said web in a direction transverse to the direction of fiber orientation, while the binder is set but the web is wet, whereby to effect reorientation of said fibers; applying to the stretched web while in its extended state a rebonding binder; and setting the rebonding binder while the web is in its extended state, to fix the web in its reoriented condition.

5. A method of treating a nonwoven fabric prepared by bonding a web of fibers predominantly aligned in one direction, which comprises applying a potential rebonding composition to the pre-bonded fabric; deforming the pre-bonded fabric in the plane of the fabric by increasing its dimensions transverse to the predominant fiber direction and decreasing its dimensions parallel to the predominant fiber direction, the fabric density in weight per square unit of area remaining substantially constant; and developing the bonding properties of the rebonding composition to anchor the fibers of said fabric to one another.

6. A method which includes providing a web comprising a major proportion of oriented textile fibers and a minor proportion of non-oriented textile fibers, united into a self-sustaining sheet by a binder infused into at least a portion of the lateral surface of said web; stretching the web in a direction transverse to the direction of fiber orientation, while the binder is set but the web is wet, whereby to effect reorientation of the originally oriented fibers; applying to the web while in its extended state a rebonding binder; and setting the rebonding binder while the web is in its extended state, to fix the fibers in their reoriented state.

7. A method of making a pseudo isotropic fabric from a web comprising a major proportion of oriented textile fibers and a minor proportion of non-oriented textile fibers united into a self-sustaining sheet by a binder infused into at least a portion of the lateral surface of said web and set therein: which method comprises stretching said web in a direction transverse to the direction of fiber orientation, while the web is wet, to effect reorientation of said fibers; applying to the web a rebonding binder; and setting the rebonding binder while the web is in its extended state, to fix the fibers in their reoriented state and produce a fabric that is substantially isotropic in its physical properties.

8. The method of claim 6 wherein said web is stretched to at least 150% of its original width.

9. The method of claim 5 wherein said web is stretched to at least 170% of its original width.

10. A method of making a pseudo isotropic fabric from a web comprising a major proportion of oriented textile fibers and a minor proportion of non-oriented textile fibers, united into a self-sustaining sheet by a binder infused into at least a portion of the lateral surface of said web and set therein; which method comprises impregnating said web with an aqueous emulsion of binder; stretching the impregnated web in a direction transverse to the direction of fiber orientation while the web is wet; and then setting said impregnating binder to fix the web in its stretched condition.

11. A method of treating a nonwoven fabric prepared by bonding a web of fibers predominantly aligned in one direction, which comprises applying an aqueous liquid to the fabric; applying a potential bonding composition to the fabric; deforming the fabric in the plane of the fabric by increasing its dimensions transverse to the predominant fiber direction and decreasing its dimensions parallel to the predominant fiber direction, the fabric density in weight per square unit of area remaining substantially constant; developing the bonding properties of the applied bonding composition to anchor the fibers of said fabric to one another and removing the liquid from the fabric.

12. In the manufacture of pseudo isotropic fabric from a web comprising a major proportion of oriented textile fibers and a minor proportion of non-oriented textile fibers, united into a self-sustaining sheet by a binder infused into at least a portion of the lateral surface of said web; the improvement which comprises impregnating said web with an aqueous dispersion of binder; stretching the impregnated web across the direction of fiber orientation, beyond the elastic limit of said web, while the web is still wet with said aqueous dispersion of binder; and then drying the web in its extended state, to set the impregnating binder and fix said web in its extended state.

13. In the manufacture of a pseudo isotropic fabric from a bonded web comprising a major proportion of oriented textile fibers and a minor proportion of non-oriented textile fibers united into a self-sustaining sheet by a binder infused into at least a portion of the lateral surface of said web, the improvement which comprises: stretching said web across the direction of fiber orientation beyond the elastic limit of said web, while the web is wet with water; applying to the web a rebonding binder; plying said stretched web with another web; and then drying the resultant laminated structure.

14. The method of claim 13 wherein said web is stretched to at least 170% of its original width.

15. A pseudo isotropic web comprising a multiplicity of generally sinuous fiber bands disposed side by side in a common plane in opposition to each other; each of said bands comprising a multiplicity of textile fibers substantially oriented with the axes of the band in which they are disposed; said bands being held in spaced relationship to each other by a binder anchoring the fibers of said web together.

16. A pseudo isotropic web comprising a multiplicity of generally sinuous fiber bands disposed side by side in a common plane in opposition to each other; each of said bands comprising a multiplicity of textile fibers substantially oriented with the axis of the band in which they are disposed; said bands being held together in spaced relationship by a binder infused into the body of said web over substantially the entire lateral surface thereof.

17. A pseudo isotropic web comprising two series of uniformly spaced, substantially symmetrical, sinuous bands of fibers arranged in opposed adjacent pairs that are approximately the reflection of each other; a third series of bands of fibers one member of which series is interposed between each of said opposed pairs of sinuous bands of the first two series, each of said bands of the three series comprising a multiplicity of unspun textile fibers substantially oriented with the axis of the band in which they are disposed; said bands being held together in a self-sustaining web in spaced relationship to each other by a binder infused into the body of said web and covering a substantial proportion of the entire lateral surface thereof.

18. A nonwoven, pseudo isotropic web comprising two series of uniformly spaced, substantially symmetrical, sinuous bands of fibers arranged in opposed adjacent pairs that are approximately the reflection of each other; a third series of bands of fibers one member of which series is interposed between each of said opposed pairs of sinuous bands and contiguous thereto at their points of apposition; each of said bands of the three series comprising a multiplicity of unspun textile fibers substantially oriented with the axis of the band in which they are disposed; said bands being bonded together into a self-sustaining web, and in spaced relationship to each other, by discrete areas of binder infused locally into said series of bands and bonding one member of each of said series of bands at their points of apposition; said bands being additionally held together in spaced relationship to each other by a binder infused into the body of said web, over substantially the entire lateral surface thereof.

19. A laminated fabric comprising a plurality of plies bonded together, at least one of said plies comprising a pseudo isotropic web, comprising a multiplicity of generally sinuous fiber bands disposed side by side in a common plane in opposition to each other, each of said bands comprising a multiplicity of textile fibers substantially oriented with the axis of the band in which they are disposed; said bands being held together in spaced relationship to each other by a binder infused into the body of said web and covering substantially the entire lateral surface thereof.

20. A nonwoven fabric having a substantially open, lacelike, reticular structure, comprising a multiplicity of substantially sinuous bands disposed side by side in a common plane and in opposition to each other, each band being the substantial reflection of the two adjacent bands on either side, each of said bands comprising a multiplicity of textile fibers substantially oriented with the sinuous bands in which they are disposed; the bands being bonded together into a self-sustaining web by a binder pattern comprising lines of binder interconnecting either adjacent or opposed sides of the figures defined by any two opposed nodes of each pair of said sinuous bands.

21. A nonwoven fabric having a substantially uniformly open, lacelike, reticular structure, comprising a multiplicity of substantially sinuous bands disposed in the common plane side by side in opposition to each other, each band being substantial reflection of the two-adjacent bands on either side, with the axes parallel and their point of apposition in juxta-position, each of said bands comprising a multiplicity of unspun textile fibers substantially oriented with the sinuous band in which they are disposed; the bands being bonded together into a self-sustaining web by two binder patterns, one pattern comprising discrete binder areas infused locally into the fibers of each pair of adjacent bands at their juxtaposed points of apposition, the other pattern comprising two series of substantially parallel, uniformly spaced lines of binder, one series extending transversely across, and the other parallel to, the axes of said sinuous bands.

22. The product of claim 21 wherein the discrete areas of said first binder pattern lie in between the lines of said second binder pattern.

23. The product of claim 21 wherein the areas of said first binder pattern are disposed substantially in the center of the grid formed by the second binder pattern.

24. The product of claim 21 wherein said lines of binder comprise continuous or uninterrupted lines of binder.

25. A method of making a nonwoven fabric which comprises cross-stretching a discontinuously bonded, laterally extensible lightweight web of substantially oriented textile fibers until the originally oriented fibers are reoriented into substantially sinuous bands disposed along parallel axes, each band being in apposition to its two neighboring bands; and then stabilizing said webs by rebonding the web with a binder pattern comprising two series of uniformly spaced lines of binder, one series intersecting the other series, whereby to provide a nonwoven fabric having a uniformly open, lacelike, reticular structure and characterized by its resistance to deformation when stressed either crosswise or lengthwise of the web.

26. A method of making a nonwoven fabric which comprises uniformly cross-extending a discontinuously bonded, laterally extensible, lightweight web of substantially oriented textile fibers, until the oriented fibers are reoriented to form substantially sinuous bands disposed along parallel axes, each band being in opposition to its two neighboring bands; and then imprinting on the stretched web a gridlike binder pattern comprising two series of substantially parallel lines, one series extending transversely across, and the other parallel to, the axes of said sinuous bands, the lines forming said gridlike pattern lying in the spaces between said discrete binder areas in the original web from which the product was produced.

27. A method of producing a nonwoven fabric which comprises bonding a substantially oriented web of textile fibers with a discontinuous binder pattern covering a minor proportion of the lateral surface of the web and comprising a multiplicity of uniformly spaced, discrete areas of binder, physically separated from, but articulated with, each other by unbonded lengths of fibers; uniformly stretching the thus bonded web in a direction transverse to the direction of fiber orientation, until the originally oriented fibers are reoriented into substantially sinuous bands disposed along parallel axes; and then rebonding said web with a gridlike pattern comprising two series of substantialy parallel lines, one series extending transversely across, and the other series parallel to, the axes of said sinuous bands, whereby to provide a nonwoven fabric having a uniformly open, lacelike, reticular structure and characterized by its resistance to deformation when stressed either crosswise or lengthwise of the web.

28. A nonwoven fabric having a uniformly lace-like, reticular structure, said fabric comprising a multiplicity of substantially sinuous bands disposed in a common plane side by side in apposition to each other, each band being the substantial reflection or mirror image of the two adjacent bands on either side, with their axes parallel and their points of apposition in juxtaposition, each of said bands comprising a multiplicity of unspun textile fibers substantially oriented with the sinuous bands in which they are disposed, the bands being bonded together into a self-sustaining web by two binder patterns, one pattern comprising discrete binder areas infused locally into the fibers of each pair of adjacent bands at the juxtaposed points of apposition, the other pattern comprising two series of substantially parallel, uniformly spaced lines of binder, one series of lines intersecting the other series of lines.

29. The fabric of claim 28 wherein said lines of binder comprise interrupted or broken lines.

30. The fabric of claim 28 wherein said lines of binder comprise continuous or uninterrupted lines.

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