United States Patent [19]

Kalwaites

[11] **3,873,255**

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[54] **APPARATUS FOR PRODUCING NONWOVEN FABRIC**

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[73] Assignee: **Johnson & Johnson,** New Brunswick, N.J.

[22] Filed: **Sept. 13, 1973**

[21] Appl. No.: **397,031**

Related U.S. Application Data

[60] Division of Ser. No. 295,768, Oct. 6, 1972, abandoned, which is a continuation-in-part of Ser. No. 110,193, Jan. 27, 1971.

[52] **U.S. Cl.** ..... **425/83,** 19/155, 19/161 P, 28/1.4, 161/109, 425/223, 425/224, 425/363

[51] **Int. Cl.** **B29c 1/14**

[58] **Field of Search**... 19/155, 165 P, 165 R, 161 P; 28/72, 12, 1.4, 57; 156/433; 161/109; 425/289, 83, 317, 324, 363, 223, 224

[56] **References Cited**

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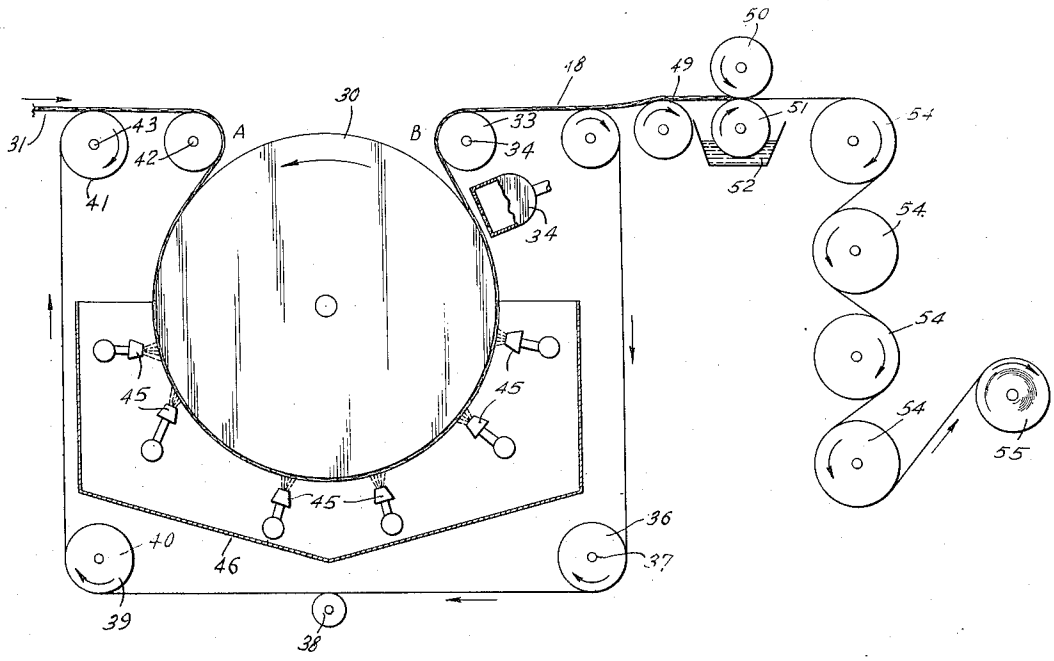
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Primary Examiner—Robert L. Spicer, Jr.

[57] **ABSTRACT**

A method of treating a layer of fibers to form a fibrous web having various areas of fiber concentration and opacity. The fiber layer is supported on an impermeable member and moving forces are applied to the supported layer. The forces move the fibers into areas of varying opacity and fiber concentration while maintaining substantially uniform density throughout these areas.

7 Claims, 18 Drawing Figures



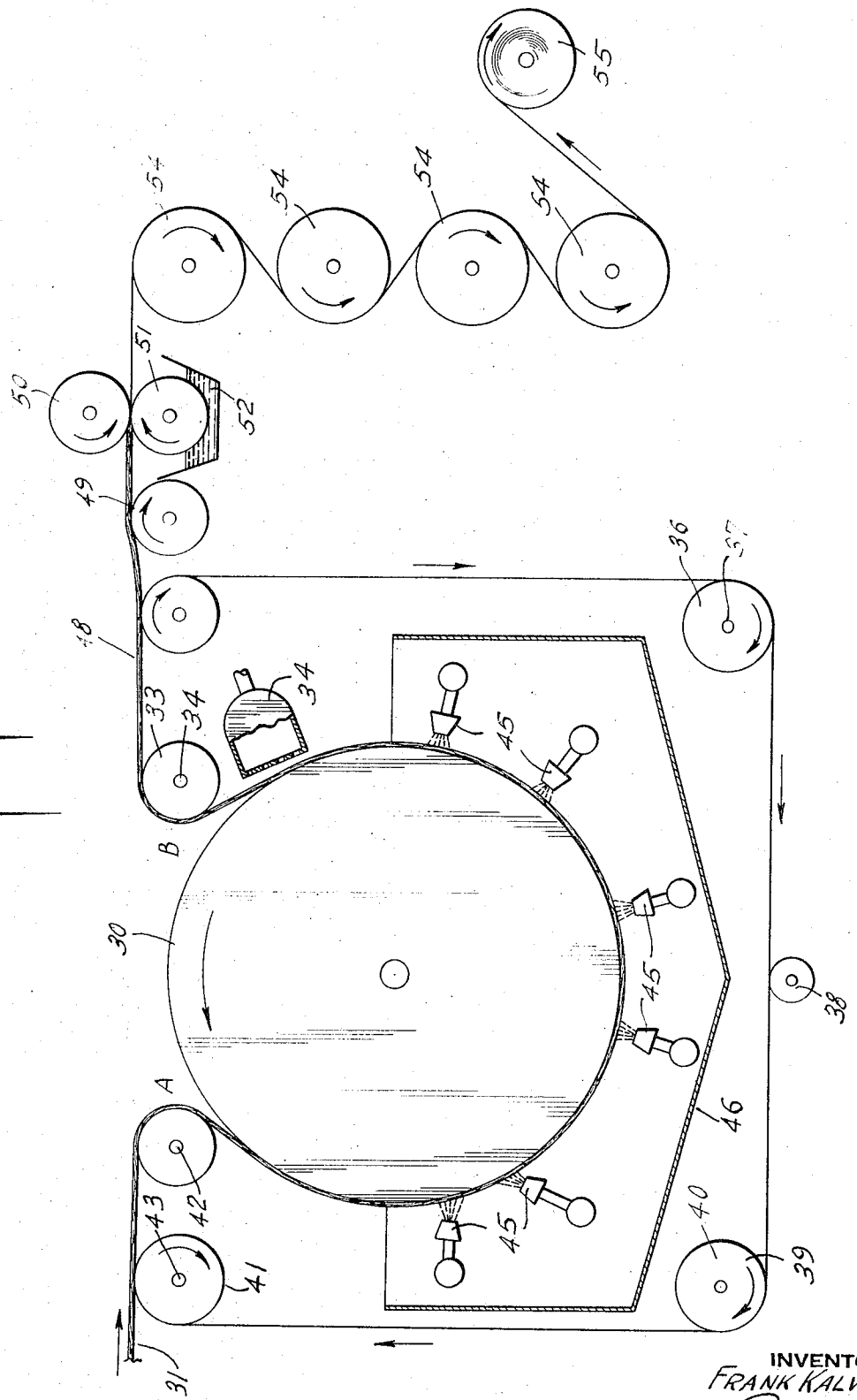


Fig. 1.

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Fig. 2.

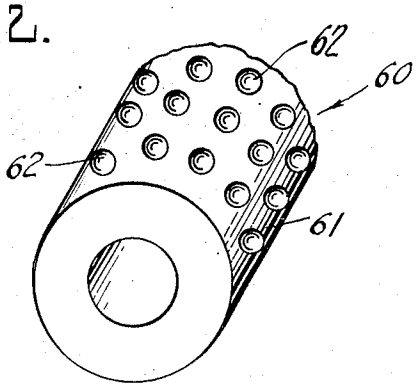


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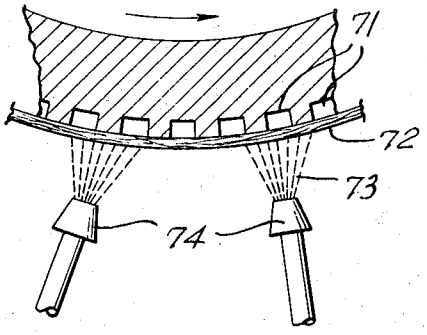


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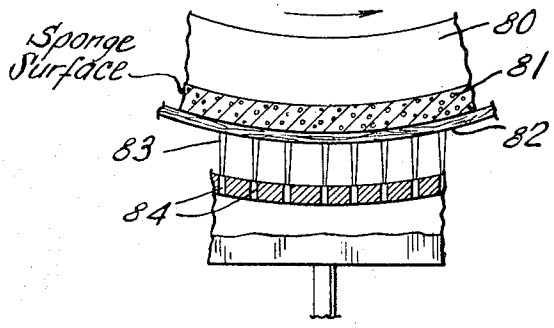


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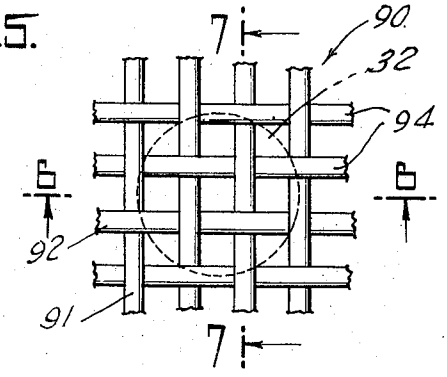


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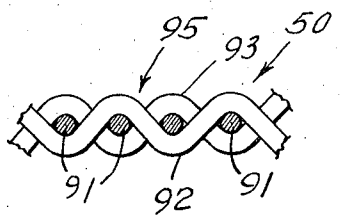
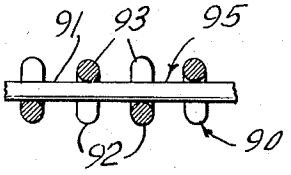


Fig. 7.



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Fig. 8.

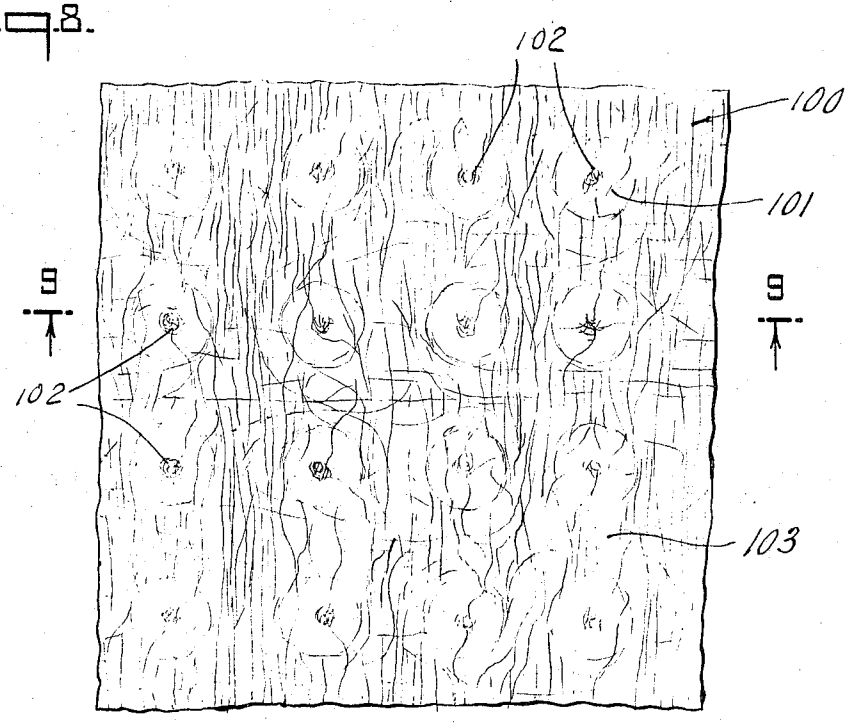


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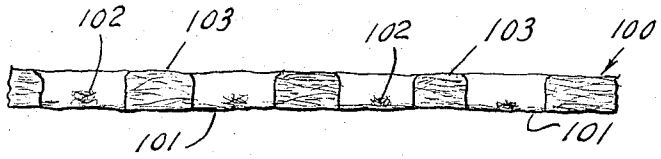


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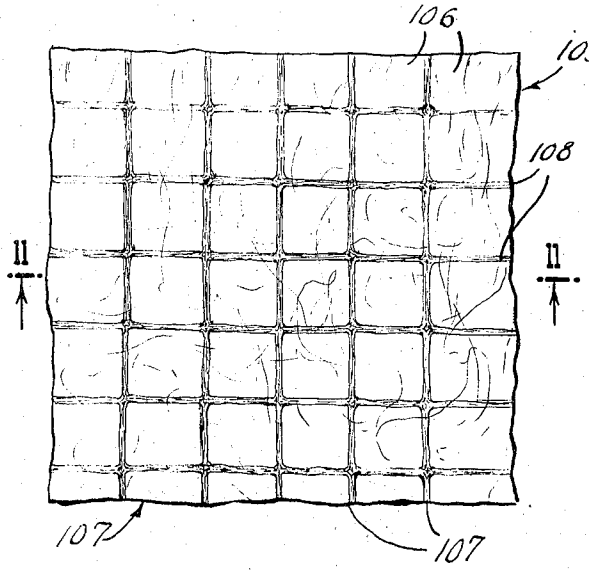
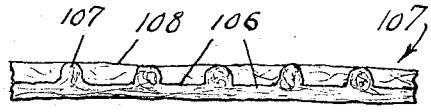


Fig. 11.



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Fig. 13.

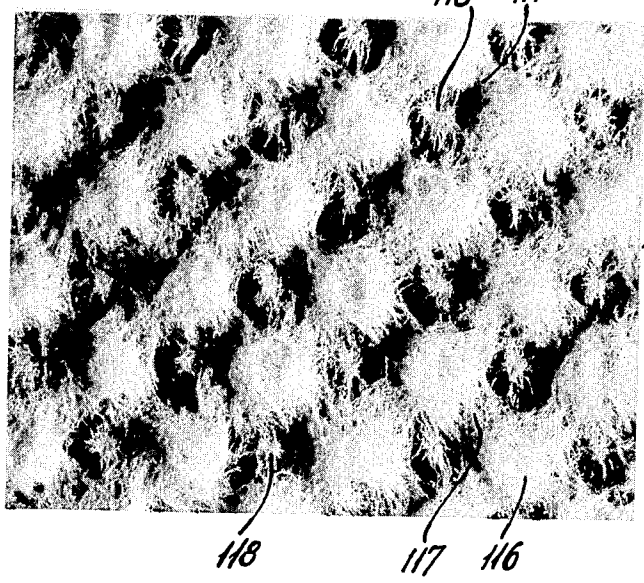
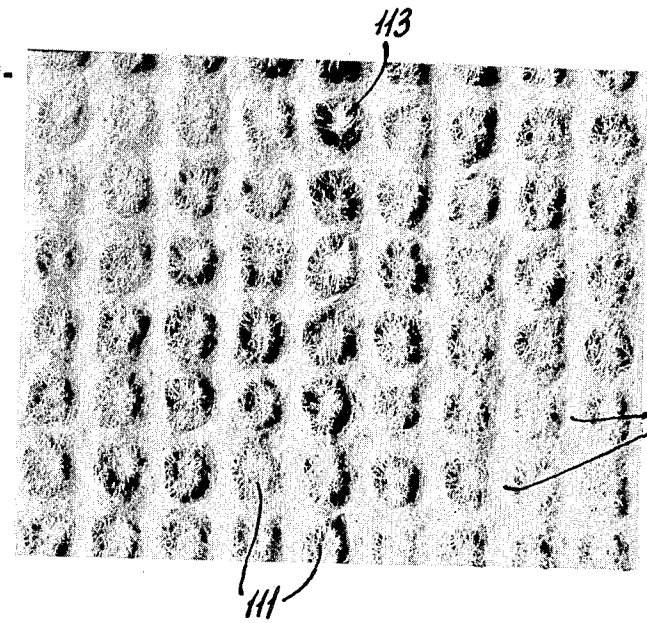


Fig. 12.



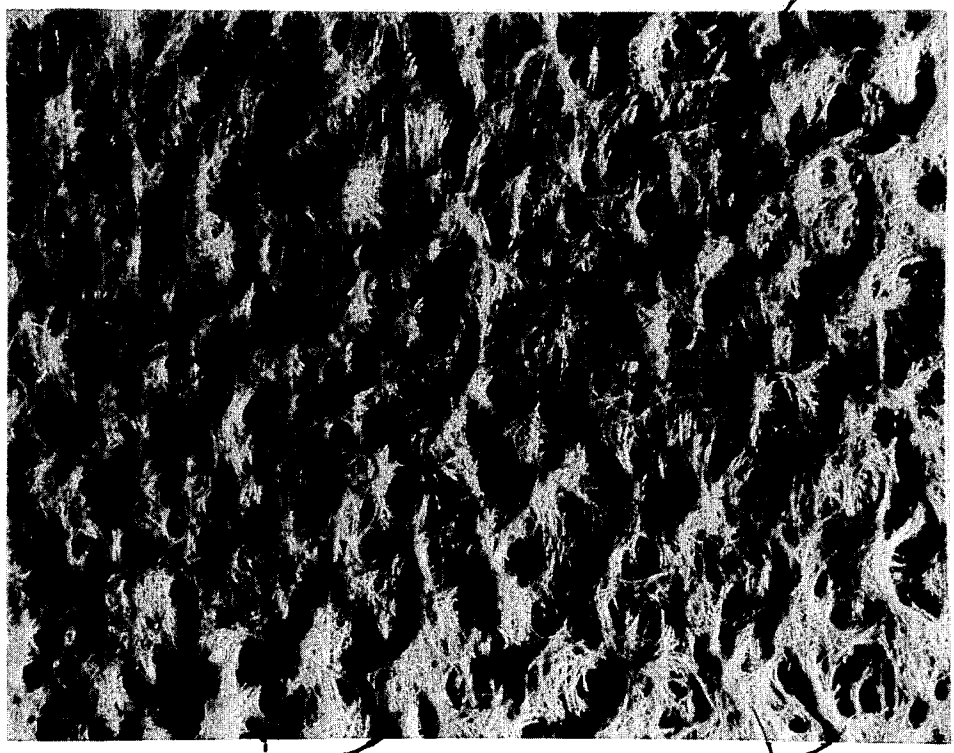


Fig. 14.

Fig. 15.

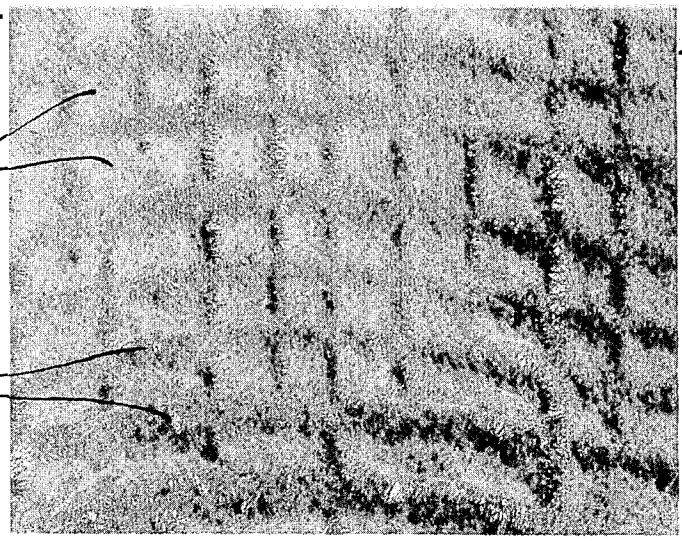


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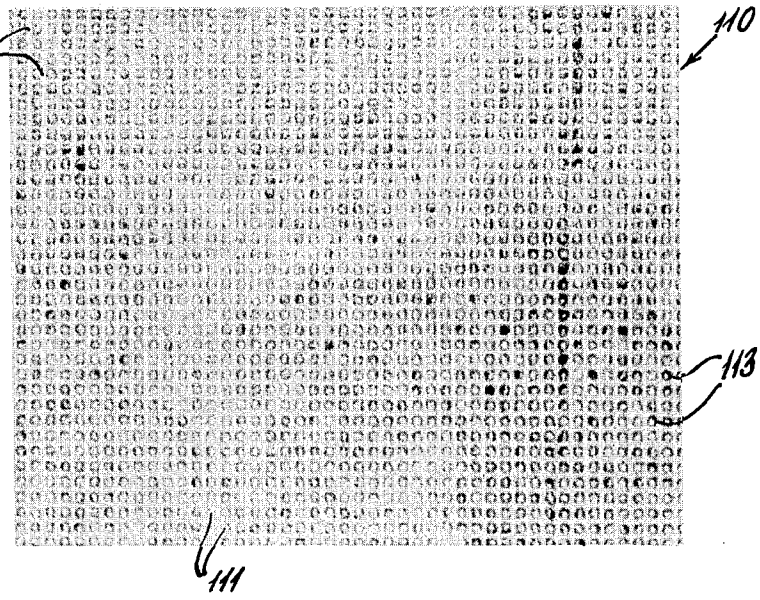


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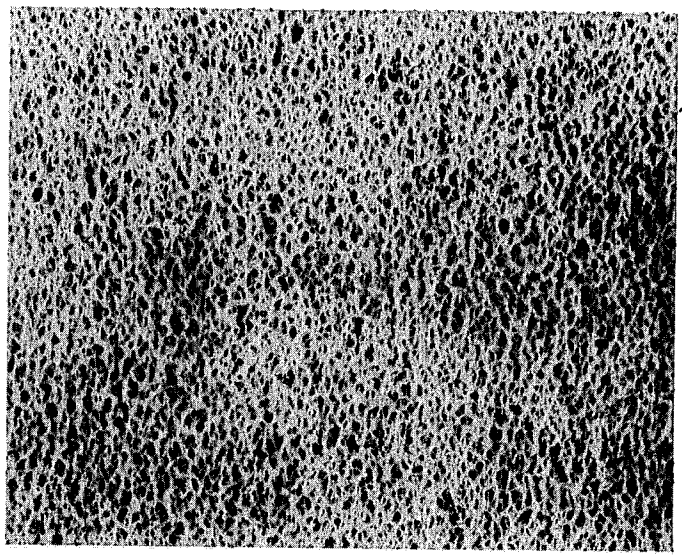
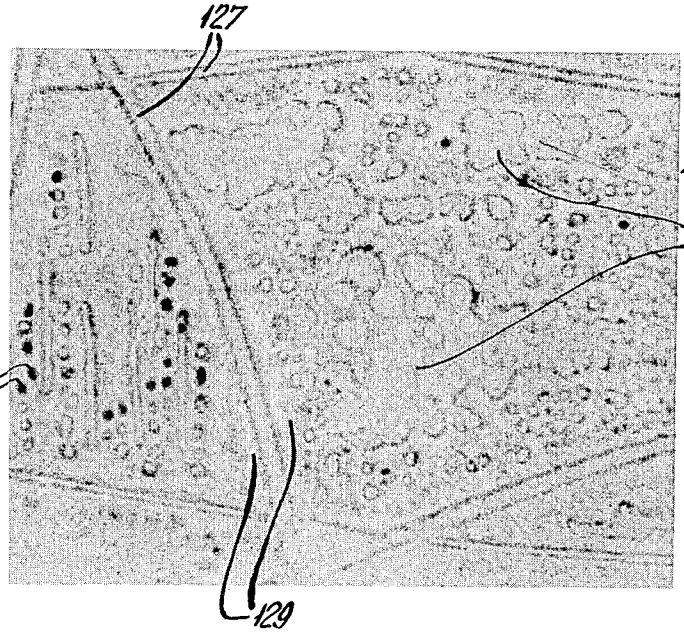


Fig. 18.



APPARATUS FOR PRODUCING NONWOVEN FABRIC

BACKGROUND OF INVENTION

This is a division, of application Ser. No. 295,768, now abandoned filed Oct. 6, 1972, which is a continuation-in-part application of Serial No. 110,193 filed January 27, 1971.

Patented nonwoven fabrics have gained considerable importance over the past years for many end uses. Nonwoven fabrics have been developed with many different types of patterns; for example, nonwoven fabrics which are bonded in patterns, nonwoven fabrics which contain patterns of holes or areas of low fiber density, and nonwoven fabrics which have an embossed pattern on them.

Patterned bonded fabrics generally comprise a layer of fibers to which a binder is applied in a pattern of lines or dots or other configurations. The binder is usually colored in order to give more aesthetic qualities to the patterned bonded fabric.

Nonwoven fabrics containing patterns of areas of low fiber density or holes usually comprise fiber segments which are formed as bundles of fibers which define these holes. In some instances, the fiber bundles may be coupled with areas of high fiber entanglement. This technique is usually used to produce a strong fabric wherein the fiber segments act together to produce strength and where portions of fibers are highly entangled to also aid in giving strength to the fabric. As a result of this fiber arrangement, the pattern will be of holes or areas of low fiber density which improve the aesthetic appeal of the fabric.

Embossed nonwoven fabrics are produced by standard embossing techniques where areas are highly compressed or densified in a pattern to produce a pleasing surface to the fabric and in some instances, to control fluid absorption of the fabric and to improve the aesthetic qualities of the fabric.

SUMMARY OF THE INVENTION

As used throughout this specification, "fiber concentration" means the number of fibers in a plan area of a fabric or web; that is, the number of fibers in a unit area of the web when the fibers throughout the thickness of the web in that area are projected into the unit area. Areas of varying fiber concentration will also have varying opacity. The higher the fiber concentration in an area, the higher the opacity or the more opaque the area. As used throughout this specification, the term "fiber density" means the number of fibers in a unit volume of the web.

I have discovered a new method for producing non woven fabrics having varying patterns which greately improves the aesthetic appeal of the nonwoven fabrics. My new method is simple and can be run at high production rates, making the process very economical.

In accordance with the present invention a layer of fibers is treated to form a fibrous web having areas of varying opacity and varying fiber concentration. The fibrous layer is supported on an impermeable patterned support member and a plurality of fiber moving forces are applied to the supported layer. A substantial portion of the fiber moving forces act in the plane of the layer, a substantial number of these forces act perpendicular to the layer, and a substantial number of these forces act at varying angles to the layer. The perpendicular and angle forces are applied and dissipated from the same side of the layer of fibers to form a pattern of areas of varying opacity and fiber concentration.

In certain embodiments of the present invention, there are few, if any, perpendicular forces applied to the layer and all the fiber moving forces act either in the plane of the layer or at an angle to the plane of the layer. However, in all instances, the forces acting at an angle to the plane of the layer are applied and dissipated from the same side of the layer.

Fabrics produced utilizing my new method vary considerably. The nonwoven fabrics produced will have areas of high opacity and areas of lower opacity arranged in a predetermined pattern throughout the fabric and all of these areas have substantially the same fiber density throughout the fabric. The areas of high opacity and of lower opacity will have different fiber concentrations. In some instances, holes also may be produced in the fabric with the holes also arranged in a predetermined pattern. In all instances, all of the fiber areas throughout the fabric will have substantially the same fiber density irregardless of their opacity.

The apparatus used in practicing my new method comprises an impermeable member having a patterened surface. The fibrous layer to be treated is placed on the impermeable patterned support member. Spaced above the support member is means for directing fluid against the fibrous layer while it is supported for applying fiber moving forces to the supported layer. Though not absolutely necessary, it is generally preferable that the fibrous layer be covered by a permeable containing member to eliminate the possibility of fiber wash away and to allow greater fiber moving forces to be applied to the layer per unit time. The apparatus also comprises means for removing the treated layer from the impermeable support member. Certain embodiments of the apparatus also include means for bonding the treated layer to produce a nonwoven fabric.

By supporting a fibrous layer on an impermeable support member and applying fiber moving forces to the layer while so supported, with the forces being applied and dissipated from the same side of the layer, these forces move the fibers into areas according to the pattern of the support member. The fiber moving forces unexpectedly form the web into areas of varying opacity rather than washing away the fibers and completely disrupting the loose weak fibrous layer. Many forces act in the plane of the web to shove fibers aside from a particular area. Many of the forces also bounce back into the direction from which new forces are being applied and unexpectedly, do not disrupt the new forces being applied but instead, cooperate with them to push the fibers into areas of varying opacity.

If the patterned support member has no resiliency, the forces applied will unexpectedly move fiber segments in the layer from one area to another area of the layer without changing the relative configuration of fiber to adjacent fiber and hence form areas in which the fiber segments are substantially as randomly laid as they were in the original layer and merely form thicker areas in the layer.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be more fully understood from the description which follows taken in conjunction with the accompanying drawings in which are illustrated pre-

ferred designs of machines and modes of operation embodying the invention along with varying types of fabrics which may be produced in accordance with the present invention. It is to be understood, however, that the invention is not to be considered limited to the constructions or modes and operations as disclosed except as determined by the scope of the appended claims.

IN THE DRAWINGS

FIG. 1 is a diagrammatic showing in elevation of one type of apparatus that may be employed in the present invention.

FIG. 2 is a fragmentary perspective view of one type of an impermeable patterned support member which may be used in the apparatus of FIG. 1.

FIG. 3 is an enlarged fragmentary diagrammatic view of means for applying fiber moving forces to a layer of fibers.

FIG. 4 is an enlarged fragmentary diagrammatic view of another means for applying a plurality of fiber moving forces to a layer of fibers.

FIG. 5 is an enlarged fragmentary diagrammatic plan view of a means for containing a layer of fibers on the impermeable patterned support member.

FIG. 6 is a cross-sectional view taken along line 6—6 of FIG. 5.

FIG. 7 is a cross-sectional view taken along line 7—7 of FIGS. 5 and 6.

FIG. 8 is a schematic plan view of a nonwoven fabric made in accordance with the present invention.

FIG. 9 is a cross-sectional view taken along line 9—9 of FIG. 8.

FIG. 10 is a plan view of another embodiment of a nonwoven fabric in accordance with the present invention.

FIG. 11 is a cross-sectional view taken along line 11—11 of FIG. 10.

FIG. 12 is a photomicrograph of a nonwoven fabric made in accordance with the present invention, shown at an original enlargement of five times.

FIG. 13 is a photomicrograph of another nonwoven fabric made in accordance with the present invention shown at an original enlargement of five times.

FIG. 14 is a photomicrograph of another nonwoven fabric made in accordance with the present invention shown at an original enlargement of five times.

FIG. 15 is a photomicrograph of another nonwoven fabric made in accordance with the present invention shown at an original enlargement of five times.

FIG. 16 is a photograph of the nonwoven fabric shown in FIG. 12.

FIG. 17 is a photograph of the nonwoven fabric shown in FIG. 14.

FIG. 18 is a photograph of a nonwoven fabric made in accordance with the present invention and similar to the fabric shown in FIG. 15.

Referring to FIG. 1 of the drawings, there is shown one form of apparatus which may be used in accordance with the present invention. The apparatus comprises a rotatable roll 30. The surface of the rotatable roll is patterned and is impermeable and is used to support the layer of fibers 31 during treatment. A foraminous containing member 32 which is an endless belt, covers a substantial portion of the periphery of the rotatable roll. The containing belt passes about the rotatable roll and separates from the roll at the guide roll 33 which rotates on a shaft 34. The belt passes over a second guide roll 35 and then downwardly around the guide roll 36 rotating on the shaft 37 and then rearwardly over vertically adjustable tensioning and tracking guide roll 38 and around guide roll 39 on shaft 40. The belt passes upwardly and around guide rolls 41 and 42, rotating on shafts 43 and 44 to be returned about the periphery of the roll 30. The roll and containing belt are moving in the same direction and at the same peripheral linear speed. The rotatable roll and the containing belt provide a treating zone between them through which a layer of fibrous materials may move to be treated under the influence of fiber moving forces.

Tension on the containing belt is controlled and adjusted by a tensioning and tracking guide roll. The guide rolls are positioned in slidable brackets which are adjustable to assist in the maintenance of proper tension of the belt. The tension required will depend upon the weight of the fibrous layer being treated and the amount of fiber movement desired.

The fibrous material to be treated is fed between containing belt and rotatable roll at point A, passes through a fiber moving zone where the fiber moving forces are applied to it and is removed in its new treated form between the rotatable roll and the containing belt at point B.

As the fibrous layer passes through the treating zone, a liquid such as water is directed against the outer surface of the containing belt by nozzles 45 mounted outside the rotatable roll. A plurality of these nozzles are mounted outside the rotatable roll and generally direct water at an angle to the surface of the rotatable roll and containing belt. The water passes through the containing belt and hits the layer of fibers and the impermeable rotatable roll and applies forces within the layer of fibers as well as at varying angles to the layer of fibers. All of the forces are applied and dissipated from the side; that is, the liquid acts in the layer of fibers and bounces back away from the layer of fibers in the same general direction from which the forces were applied. The liquid is caught in a suitable catch basin 46 and recycled for further use.

A vacuum assist box 47 is located outside the containing belt and aids in dewatering the fibrous layer after it passes through the treating zone. The treated layer 48 is removed from the containing belt and passes over a roller 49 and through a pair of bonding rolls 50 amd 51. The bottom roll 51 is partially immersed in a pan 52 containing a suitable binder material. The roll 51 is engraved in a pattern and picks up binder in this pattern and applies it to the layer of fibers. The layer of fibers with the binder thereon is dryed over suitably heated rums 54 and wound up on a standard wind-up mechanism 55.

In FIG. 2, there is shown an enlarged fragmentary view in perspective of one type of impermeable support member 60 which may be used in accordance with the present invention. The surface 61 of the roll is solid and has a plurality of depressions 62 arranged over the surface in a pattern.

The depressions or raised areas, as the case may be, in the impermeable support member may have varying configurations, that is, they may be circular, oval, rectangular, square, or other shapes. These areas may be arranged either diagonally or in an aligned relationship over the surface of the roll.

Referring to FIGS. 3 and 4, there are shown enlarged fragmentary views of types of fiber moving zones. In

FIG. 3, there is shown an impermeable support member comprising a solid roll 70 having a pattern of square depressions 71 arranged over the suface. The fibrous layer 72 to be treated is placed on the surface of the roll. A liquid 73 such as water is directed against the layer while it is supported, by a plurality of spray nozzles 74. The spray from the nozzles overlaps so that the entire layer is treated. The water enters the fibrous layer in an angular fashion so that forces act within the fibrous layer at an angle or in the plane of the layer and bounce back out of the layer at an angle.

In FIG. 4, again there is shown an impermeable support member 80 having an absorbent surface 81 such as a foam or similar material. The layer of fibers 82 to be treated is placed on the absorbent surface and a liquid 83 such as water is directed at the layer of fibers, while so supported, by a plurality of jets 84. The surface 81 and the layer of fibers 82 move in the direction of the arrow as shown and the water hits the layer and applies forces to the layer of fibers to form areas of varying fiber concentrations and the water bounces back out of the layer of fibers.

Whether or not a containing belt is required during the fiber treatment will depend upon many variables, for example, the weight of the fibrous web being treated, the speed of operation, the force or pressure of the liquid being applied during the treatment, the manner in which the liquid is applied, that is, the varying angular directions and whether a fine spray or a stream of water is used. Generally, fiber movement can be accomplished at a greater rate of speed when a containing belt is used. The containing belt is merely to hold the fibers in the treating zone and prevent them from being bounced out of the treating zone. Virtually, any permeable open member may be used such as an open woven cloth or nylon belt.

FIG. 5 is an enlarged fragmentary diagrammatic plan view of one type of containing belt which may be used in the apparatus of FIG. 1. Foraminous portions 90 of the containing belt for use in this invention are formed of coarse woven screen. In the embodiment shown, wires 91 running vertically in FIG. 5 are straight and wire 92 running horizontally in that Figure weave alternately over and under wires 91. Protuberances 93 are present throughout foraminous portions 90 as the topmost part of each "knee" of a given strand 92 of the screen that is formed as the strand weaves over and under the strands 91 that lie perpendicular to it.

As a given strand 92 slants downward to pass under a strand 91 perpendicular to it, it crosses two other strands 92 disposed on either side of it, as those strands slant upward to pass over the same perpendicular strands that the given strand will pass under. Each eries of such "crossing points" 94 forms a trough, such as trough 95 formed by crossing points 94 in FIGS. 5 and 6, that lies between adjacent protuberances 93. The effective shape of troughs 95, as can be best seen in FIG. 6 (which shows a cross section of element 90 of which a plan view is given in FIG. 5) is substantially an inverted triangle.

A series of slightly deeper troughs 96 is formed between adjacent protuberances 93. As best seen in FIG. 7, the bottom of each trough 96 is formed by portions of straight strands 91, with successive protuberances 93 on each side of the trough forming the tops of troughs. As seen in FIG. 7, the effective shape of troughs 96, may be characterized as a shallow U-shape.

Use in the method or apparatus of this invention of a containing belt such as shown in FIGS. 5 through 7, produces a pattern of untreated areas in the fibrous web. These untreated areas correspond to the high points of the containing belt where this belt is held against the impermeable support member and locks that portion of the fibers to the impermeable support member so that it cannot be treated. This technique forms some very interesting patterns in the final web of fibers.

Portions of the streams of treating fluid pass through the containing belt and the layer of fibers and are directed in the layer of fibers and also directed back out of the layer of fibers at varying angles to the layer of fibers. The liquid forces are dissipated from the same side of the layer of fibers to which they were directed. These varying forces move the fibers in accordance with the pattern in the impermeable support member and/or the pattern in the restraining belt to form areas of varying fiber concentration. In certain embodiments, the forces may even form openings or holes in the layer of fibers and in other embodiments if the containing belts as described in conjunction with FIGS. 5–7 are used, will form patterns in the fibrous layer in which the fibers are untreated and remain in their original configuration and concentration.

The treated web produced by the practice of this invention, may be further treated with an adhesive, dye or other impregnating, printing or coating material in a conventional manner. For example, to strengthen a fibrous web, any suitable adhesive bonding materials or binders may be included in an aqueous or non-aqueous medium employed as the treating fluid. Or, an adhesive binder may, if desired, be printed or sprayed on the treated web to provide the necessary fabric strength. Thermoplastic binders may, if desired, be applied to the treated web in powder form or fiber form during or after treatment and then fused to bond the other fibers.

The optimum binder contents for a given fabric according to this invention depends upon a number of factors, including the nature of the binder material, size and shape of the binder members, and their arrangement in the fabric, the nature and length of the fibers' total fiber weight, and the like. In some instances because of the strength of the fibers used or the type of interentanglement in the treated web or fabric, no binder at all need be employed to provide a usable fabric.

The starting material used in the method or apparatus of this invention may be any of the standard fibrous webs such as oriented card webs, isowebs, air-laid webs, or webs formed by liquid deposition. The webs may be formed in a single layer or by laminating a plurality of the webs together. The fibers in the web may be arranged in a random manner or may be more or less oriented as in a card web. The individual fibers may be relatively straight or slightly bent. The fibers intersect at various angles to one another such that generally speaking, the adjacent fibers come into contact only at the points where they cross. The fibers are capable of movement under forces applied by fluid, such as water, air, etc.

To produce a fabric having the characteristic hand and drape of a textile fabric, the layer of starting material used in the method or apparatus of this invention may comprise natural fibers such as cotton, flax, etc.; mineral fibers, such as glass; artificial fibers, such as

viscose rayon, cellulose acetate, etc.; or synthetic fibers such as the polyamides, the polyesters, and acrylics, and polyolefins, etc., alone or in combination with one another.

The fibers used are those commonly considered textile fibers which generally are from about ¼ inch to about 2 ½ inches. Satisfactory products may be produced in accordance with the present invention from starting webs weighing between **80** grains per square yard to 2,000 grains per square yard or higher.

The treating fluid for use in this invention is preferably water or a similar liquid but it may be other fluids such as gas, etc.

The new nonwoven fabrics produced by the methods of the present invention may have a very wide variety of patterns of holes, areas of varying fiber concentration or both. Also, the holes and areas of varying fiber concentration may have varying configurations, as previously mentioned.

Referring to the drawings in FIGS. **8** and **9**, there is shown a nonwoven fabric **100** of the present invention. The fabric comprises circular areas **101** running the length and width of the fabric. In the center of each circular area is a cluster **102** of fiber portions. The circular areas are connected by fiber areas **103** extending continuously throughout the fabric. The fiber areas **103** have a certain fiber concentration which is substantially uniform throughout the fabric and as is more clearly shown in FIG. **9**, the area **103** is the thickest portion of the fabric. The circular areas **101** have a lower fiber concentration and are thinner than areas **103.** The circular areas are less opaque than the remainder of the fabric.

In FIGS. **10** and **11**, there is shown another embodiment of the nonwoven fabric of the present invention. The nonwoven fabric **105** comprises square areas **106** of low fiber concentration and low opacity. The fibers in the square areas are arranged in helter-skelter, intersecting relationship. The fabric has a plurality of longitudinal extending lines **107** and transversely extending lines **108** which intersect each other. The fibers in these lines are also in helter-skelter, intersecting relationship. The lines have a considerably higher fiber concentration, than the square areas and as is seen in FIG. **11**, are thicker than the square areas.

A similar fabric to the fabric described in conjunction with FIG. **8** is shown in the photomicrograph FIG. **12.** The fabric **110** comprises circular areas **111** of low fiber concentration. The circular areas are surrounded by and connected by areas **112** of higher fiber concentration. The fibers themselves in all areas of the fabric are in random, helter-skelter intersecting relationship. This same fabric is shown in the photograph shown in FIG. **16.**

In the photomicrograph shown in FIG. **13**, the fabric **115** comprises circular areas **116** of high fiber concentration. The circular areas are in staggered rows and are connected diagonally throughout the fabric by fiber bands **117** of medium fiber concentration. The remaining areas **118** of the fabric have a very low fiber concentration and in some instances are partial holes or openings in the fabric.

Referring to FIG. **15**, there is shown another embodiment of the new nonwoven fabric **120** of the present invention. The fabric comprises square areas **121** arranged longitudinally and transversely of the fabric. The areas **121** are discontinuous and have a higher fiber concentration than the remainder of the fabric. These areas **121** are also more opaque than the longitudinal and transverse lines **122** that connect the areas.

In FIG. **18**, there is shown a photograph of a fabric **125** similar to that shown in FIG. **15** except the pattern of high fiber concentration areas and low fiber concentration areas is different and considerably more complex. The discontinuous areas of random configuration **126** have a low fiber concentration and even some holes **127** are present. The lines **128** also have a low fiber concentration. The remaining area **129** of the fabric has a high fiber concentration which is substantially uniform throughout the fabric.

The following are illustrative Examples of the use of the method and apparatus of this invention to produce webs having patterns of varying fiber concentrations.

EXAMPLE I

In apparatus as illustrated in FIG. **1**, a web of loosely-assembled fibers such as may be obtained by carding, is fed between containing belt **32** and impermeable support roll **30.** The web weighs about 400 grains per square yard and its fiber orientation ratio is approximately 7:1 in the direction of travel. The web contains **40%** viscose rayon fibers approximately ⅜ inch long of 1½ denier, and 60% wood pulp. The impermeable support roll used in this Example has about 100 round nubs or raised areas per square inch, each approximately 0.035 inches in diameter and 1/16 inch high. The areas are arranged in rows aligned across the roll and about the periphery of the roll. The containing belt used comprises a woven nylon screen of approximately 90 × 90 construction or substantially 8,100 openings per square inch. The belt has approximately 60% open area.

Water is projected from nozzles through the containing belt against the support member. The water is directed at pressures of about 80 to 100 psi. The nozzles used are conventional solid cone nozzles and the water is directed at the rate of 1.3 gallons per minute in the treating zone. The treated fabric then passes to the take-off zone and leaves thet apparatus. With the conditions indicated, good fiber movement is obtained and an excellent material such as shown in the schematic drawings in FIGS. **8** and **9**, and the photomicrograph of FIG. **12** and the photograph of FIG. **16** is obtained.

The fabric **110** of FIG. **12** contains a continuous pattern of a high fiber concentration **112** extending substantially uniformly throughout the faric. Disposed on this pattern are circular ares **111** of low fiber concentration. These circular areas are disposed longitudinally and transversely of the fabric. In substantially the center of each circular area there is an area or cluster **113** of yet another fiber concentration which is basically the originally untreated portion of the layer of fibers.

In FIG. **16**, there is a photograph of the fabric which shows the overall aesthetic appeal formed in the fabric by the patterns of varying fiber concentrations.

EXAMPLE II

FIGS. **10** and **11** are a schematic plan and a cross-sectional view of another nonwoven fabric made in accordance with the present invention with the use of apparatus similar to that described in Example i with the exception that the impermeable support member used contains a pattern of discontinuous raised square areas. There are approximately 100 square areas per square

inch and these areas run longitudinally and transversely of the support member. The square areas are about 0.075 inch by 0.075 inch.

The containing belt used, rather than having high protuberances described in conjunction with Example I, has a relatively smooth surface. The resultant fabric comprises a pattern of square areas corresponding to the pattern of square areas in the support member which have a low fiber concentration with a continuous pattern of transversely and longitudinally running lines having areas of high fiber concentration. A photomicrograph of this fabric is shown in FIG. **15** and an actual photograph showing the aesthetic appeal of these types of fabric is shown in FIG. **18.**

EXAMPLE III

Using the apparatus as illustrated in FIG. **1,** a web of loosely assembled fibers such as may be obtained by carding, is fed between the impermeable support means **30** and a containing belt **32.** The web weight is about 400 grains per square yard and its fiber orientation ratio is approximately 7:1 in the direction of travel. The web contains viscose rayon fibers approximately 1 9/16 inches long of 1 ½ denier.

The impermeable support member has about **25** substantially round depressions per square inch. Each depression is approximately ⅛ inch in diameter and 1/16 inch deep and these depressions are arranged in a diamond pattern over the support member. The containing belt used is that described in conjunction with Example I and is shown in FIGS. **5** and **7.** Water is directed against the containing belt as described in conjunction with Example I. With the conditions indicated, good fiber treatment is obtained and an excellent nonwoven fabric such as shown in the photomicrograph of FIG. **13,** is produced. The fabric of FIG. **13,** contains a discontinuous pattern of circular areas **116** of high fiber concentration arranged in accordance with the pattern of the depressions in the impermeable support member. These circular areas are connected in a diagonal direction of the fabric by areas of medium fiber concentration **117** and form an opening **118** or hole in the fabric. The center of the opening has a fiber area corresponding to the high points of the containing belt. The fiber configuration in these areas is substantially the same as in the original web.

EXAMPLE IV

The fibrous starting material and the apparatus employed in this Example are the same as those employed in Example III with the exception that the support member is a smooth surfaced rotatable roll which is impermeable but has a surface covered with polyurethane foam material approximately ⅛ inch thick. The resulting fabric **134** is seen in FIGS. **14** and **17** and comprises a random pattern of areas **135** of varying fiber concentration with a random pattern of holes **136** extending throughout the fabric.

The above detailed description has been given for clearness of understanding only. No unnecessary limitations should be understood therefrom as modifications will be obvious to those skilled in the art.

I claim:

1. Apparatus for treating a layer of fibers to form a web of fibers having areas of varying opactiy and varying fiber concentration comprising: impermeable, patterned support means for supporting a layer of fibers over a substantial portion of its area, means for directing fluid against said layer of fibers while said layer is supported to produce fiber moving forces acting in the plane of the layer and at various angles to the layer, said support means being capable of reflecting the fluid directed against the supported layer so that fluid forces are applied and dissipated from the same side of the layer of fibers, and means for removing said fluid from the layer to produce a web of fibers.

2. Apparatus according to claim **1** wherein the impermeable, patterned support means comprises a rotatable roll having a non-resilient patterned surface.

3. Apparatus according to claim **1** wherein the impermeable, patterned support means comprises a rotatable roll having a resilient surface.

4. Apparatus according to claim **1** including a foraminous belt for containing the layer of fibers on the impermeable patterned support means.

5. Apparatus according to claim **1** wherein the means for directing fluid against the layer of fibers is spray nozzles positioned to direct fluid against the layer of fibers while said layer is on said support means.

6. Apparatus according to claim **1** wherein the means for removing fluid from the layer is vacuum means.

7. Apparatus according to claim **1** wherein the impermeable patterned support means comprises a rotatable roll, a foraminous containing belt adjacent a substantial portion of the periphery of said roll for containing the layer of fibers against the roll while said layer is supported by the roll, means for driving the roll and belt so that there is no relative movement between the roll and belt and the means for directing fluid against the layer of fibers is spray nozzles positioned on the opposite side of the belt from said support means.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,873,255 Dated March 25,1975

Inventor(s) Frank Kalwaites

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In Column 4, line 36, "the side" should read --- the same side ---.

In Column 4, line 48, " 50 amd 51" should read --- 50 and 51 ---.

In Column 4, line 52, "heated rums 54" should read --- heated drums 54 ---.

In Column 8, line 42, "leaves thet apparatus" should read --- leaves the apparatus ---.

In Column 8, line 49, "faric" should read --- fabric ---.

In Column 8, line 50, "ares" should read --- areas ---.

In Column 8, line 64, "Example i" should read --- Example 1 ---.

Signed and Sealed this

fifth Day of *August 1975*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks