Aug. 27, 1963 W. L. GEORGE ET AL 3,101,520

METHOD AND APPARATUS FOR MAKING BRUSHED NONWOVEN FABRIC

Filed April 6, 1960 3 Sheets-Sheet 1

Fig. 1.

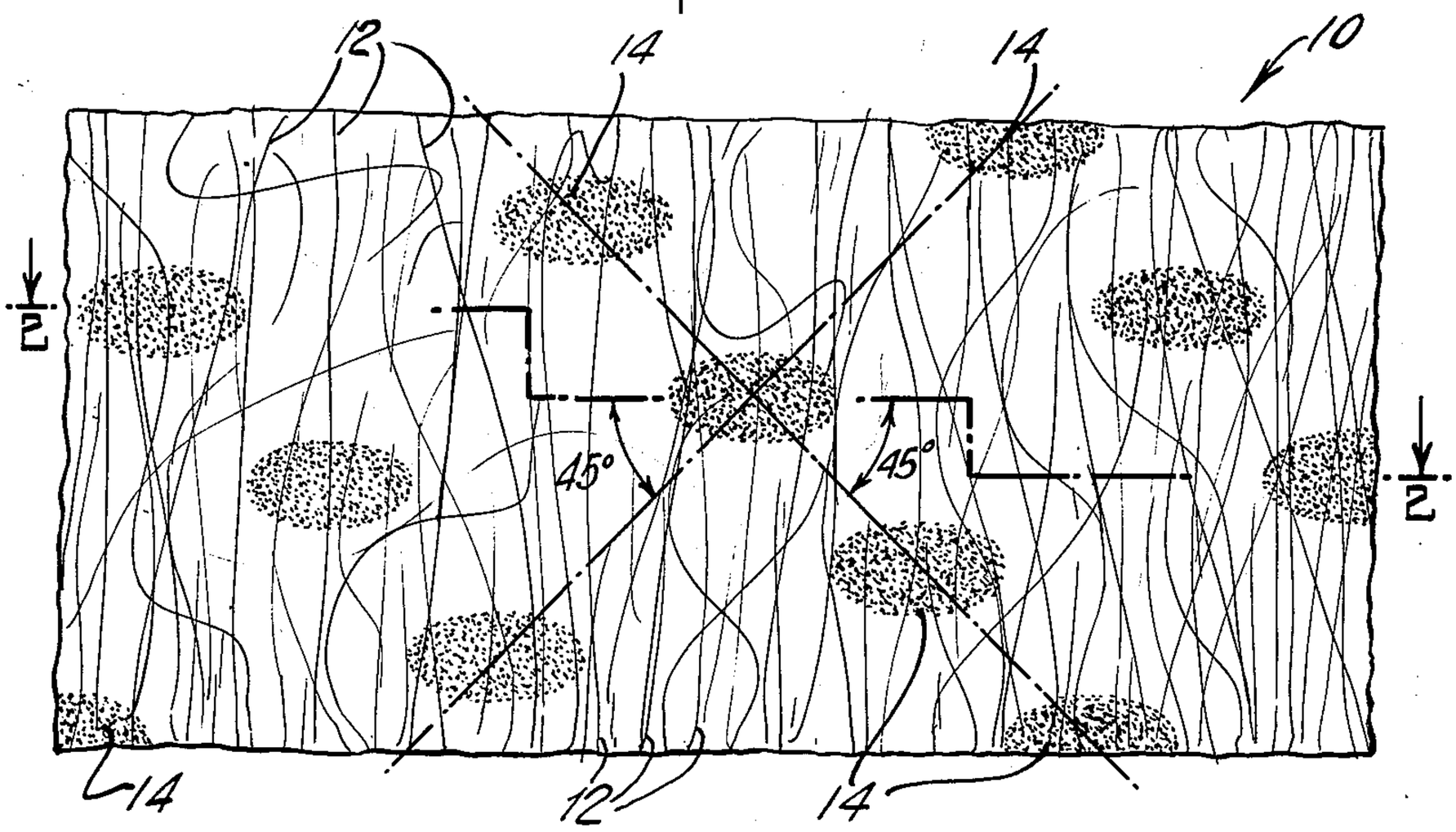
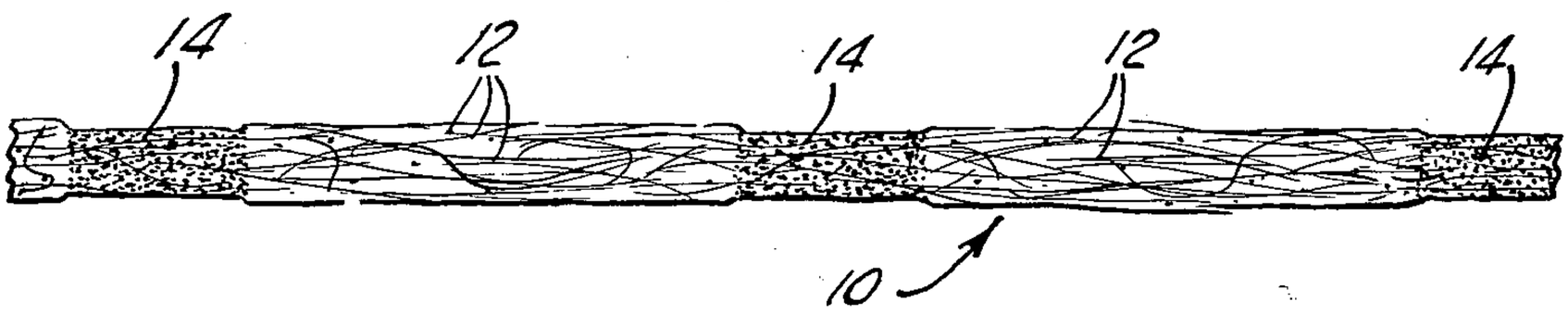



Fig. 2.

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METHOD AND APPARATUS FOR MAKING BRUSHED NONWOVEN FABRIC

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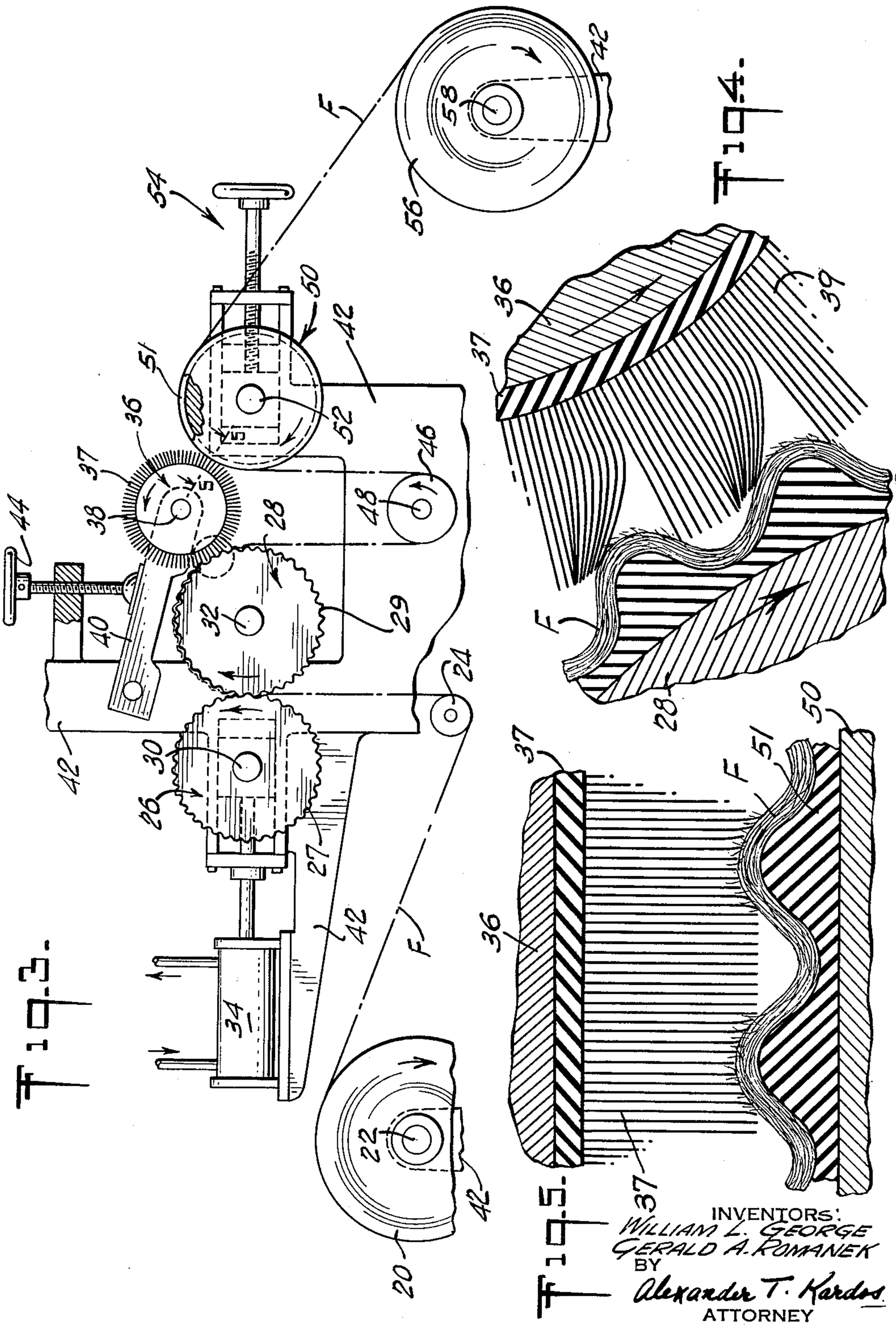

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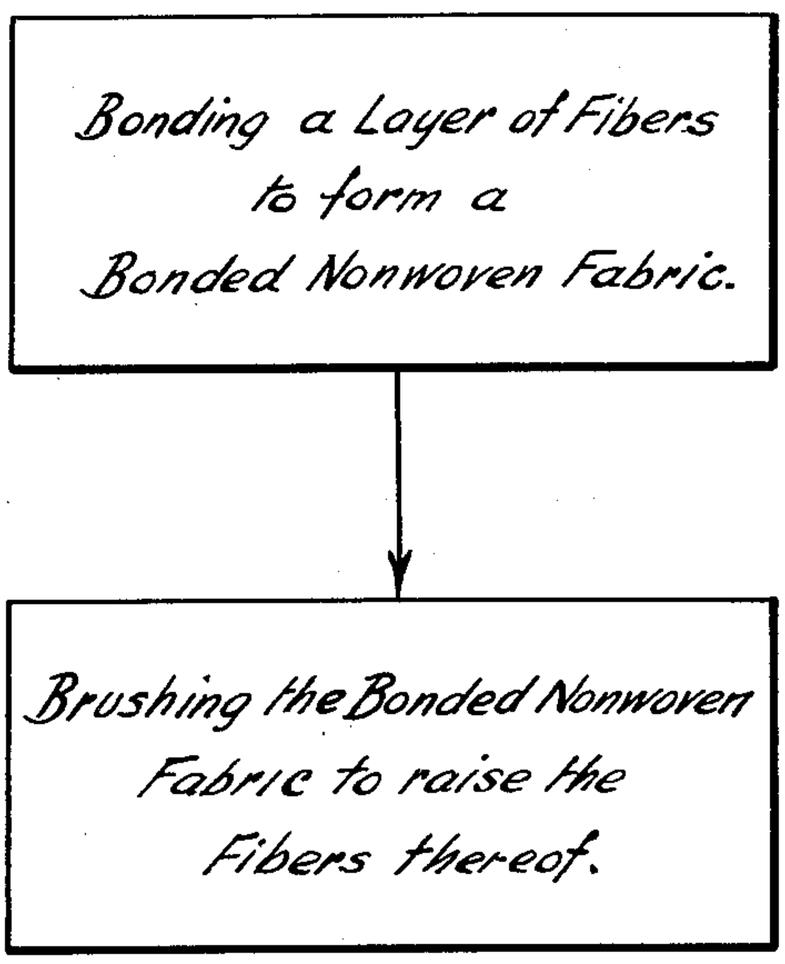
# METHOD AND APPARATUS FOR MAKING BRUSHED NONWOVEN FABRIC

Filed April 6, 1960 3 Sheets-Sheet 3

Fig. 6.

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# 3,101,520
# METHOD AND APPARATUS FOR MAKING BRUSHED NONWOVEN FABRIC

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4 Claims. (Cl. 28—1)

The present invention relates to novel, bonded and brushed nonwoven fabrics and to improved methods and apparatus for making the same. More specifically, the present invention is concerned with novel, bonded and brushed nonwoven textile fabrics wherein the surface fibers have been brushed and extend outwardly from the main body of such fabrics to provide a high degree of softness thereto, without materially reducing the strength characteristics of the bonded nonwoven fabric.

One of the most common ways to impart softness to a textile fabric is to lightly brush its surface to raise a fibrous nap or pile thereon. Such methods have been applied to fabricated textiles, such as woven or knitted goods, and have found commercial acceptance where such increased softness is desired or required.

When such brushing techniques are applied to conventional nonwoven textile fabrics, there is an increase in the softness of the fabric but it is accompanied by such a large loss in strength that such techniques are resorted to only where strength is of no consideration in the final product. Careful examination of the brushed nonwoven fabric reveals that, even with a relatively light brushing action, many of the fibers, particularly those which are "non-oriented" with respect to the direction of brushing, are either ruptured or pulled out of the binder areas which bond the fabric together, whereby considerable loss in strength ensues.

It is therefore a principal purpose of the present invention to provide improved methods and apparatus for making a novel, bonded and brushed nonwoven fabric having a high degree of softness without suffering any substantial loss in fabric strength.

It has been discovered that such a purpose may be achieved by initially bonding the nonwoven fabric with a non-migratory binder in a predetermined pattern of spaced miniature binder areas of specified size and spacing extending across the nonwoven fabric at an angle to the long direction thereof, and then brushing the nonwoven fabric to raise the desired nap or pile. The predetermined pattern, size and spacing of the miniature binder areas and the nature of the non-migratory binder is critical and must conform to limited specifications set forth hereinafter in order that a cooperative effect be realized with the subsequent brushing step in such a way that the fabric softness is increased without rupturing or pulling very many surface fibers out of the binder areas whereby loss in strength is avoided.

It has also been discovered that the cooperative effect between the bonding with miniature binder areas and the subsequent brushing may be enhanced by brushing the bonded nonwoven fabric over only a portion of its surface whereby the rupturing of fibers or their separation from the binder areas is even further minimized and the loss in strength even further reduced.



In the accompanying drawings and following specification, there are illustrated and described preferred embodiments of the present invention but it is to be understood that the inventive concept is not to be considered limited thereto, except as determined by the scope of the appended claims. With reference to the accompanying drawings:

FIGURE 1 is a greatly enlarged fragmentary, schematic plan view of a novel, bonded and brushed nonwoven fabric of the present invention having a particular predetermined pattern of miniature oval binder areas;

FIGURE 2 is a cross-section of the novel, bonded and brushed nonwoven fabric illustrated in FIGURE 1, said cross-section being taken on the line 2—2 of FIGURE 1;

FIGURE 3 is a schematic view in elevation illustrating a specific embodiment of a method and apparatus for making the novel, bonded and brushed nonwoven textile fabric of the present invention;

FIGURE 4 is a fragmentary schematic view in enlarged scale, taken of the area encircled in FIGURE 3, showing the brushing action in greater detail;

FIGURE 5 is a fragmentary schematic view in enlarged scale, taken on the line 5—5 of FIGURE 3; and

FIGURE 6 is a simplified block diagram showing the basic steps of the method of the present invention.

With reference to the drawings and more particularly to FIGURES 1 and 2, there is illustrated a nonwoven fabric 10 comprising a layer of overlapping and intersecting fibers 12 which are bonded or held together by a particular predetermined pattern of spaced rows of oval or elliptical binder areas 14 extending in rows across the nonwoven fabric at an angle of 45° to the long axis of the nonwoven fabric.

The layer of overlapping and intersecting fibers 12 may be formed by any one of a number of conventional techniques for depositing, arranging, or rearranging fibers in a web. These techniques include carding, garnetting, air-laying, papermaking methods and the like. Individual webs or thin layers formed by one or more of these techniques may be laminated to provide a thicker layer for conversion into a fabric. In general, the individual fibers extend in a plurality of diverse directions in general alignment with the major plane of the fabric, overlapping, intersecting and supporting one another to form an open porous fibrous structure. The degree of fiber orientation in any particular direction will depend primarily upon the method of formation of the web. Webs formed by air-laying techniques normally have very little orientation in any particular direction and are basically isotropic. On the other hand, webs formed by carding and garnetting techniques are more or less predominantly oriented in the long direction of the web. Each type of web has its own properties and characteristics and each is useful for particular purposes. Reference is made to U.S. Patents 2,862,251; 2,705,687; 2,705,688; and 2,676,363 which disclose typical methods and apparatus for making such fibrous webs.

The fibrous web which is processed to form the products of this invention may contain natural or synthetic, vegetable, animal or mineral fibers such as cotton, silk, wool, vicuna, mohair, alpaca, flax, ramie, jute, etc.; synthetic or man-made fibers such as the cellulosic fibers, notably cuprammonium, viscose or regenerated cellulose fibers; cross-linked cellulosic fibers such as "Corval" and

"Topel"; cellulose ester fibers such as cellulose acetate ("Celanese") and cellulose tri-acetate ("Arnel"); the saponified cellulose ester fibers such as "Fortisan" and "Fortisan-36"; the polyamide fibers such as nylon 420, nylon 6 (polycaprolactam), nylon 66 (hexamethylene diamine-adipic acid), nylon 610 (hexamethylene diamine-sebacic acid), nylon 11 (11-amino undecanoic acid—"Rilsan"); protein fibers such as "Vicara"; halogenated hydrocarbon fibers such as "Teflon" (polytetrafluoroethylene); hydrocarbon polyolefin fibers such as polyethylene and polypropylene; polyester fibers such as "Kodel" and "Dacron"; vinyl fibers such as "Vinyon" and saran; acrylic fibers such as "Orlon," "Acrilan," "Creslan," etc.; modacrylic fibers such as "dynel" and "Verel"; mineral fibers such as glass, metal; etc.

The lengths of the fibers in the starting fibrous web may vary from about ⅜ inch or ½ inch up to about 2½ inches or more in length, depending upon the particular properties and characteristics required or desired in the resulting fibrous web. If desired, the fibrous layer may have added thereto, by a subsequent processing step, if necessary, from about 1 or 2% by weight up to about 100% by weight of fibers other than those of textile length. In special cases, all of the textile length fibers may be replaced by fibers other than of textile length. These other fibers may be of papermaking length, which extend from about ⅜ inch in length down to about 1/16 of an inch or less in length, which shorter fibers normally are not used in conventional methods of producing fibrous webs.

Illustrative of these short papermaking fibers are the natural cellulosic fibers such as woodpulp and wood fibers, cotton linters, cotton hull shavings fibers, mineral fibers such as asbestos, glass, rock wool, etc., or any of the hereinbefore-mentioned natural or synthetic fibers in lengths less than about ⅜ inch and down to about 1/16 of an inch or less.

The denier of the individual synthetic fibers referred to above is preferably in the range of the approximate thickness of the natural fibers mentioned and consequently deniers in the range of from about 1 to about 5 are preferred. Where greater opacity or greater covering power is desired, special fiber deniers of down to about ¾ or even about ½ may be employed. Where desired, deniers of up to about 8, 10, 15, or higher may be used. The minimum and maximum denier are naturally dictated by the desires or requirements for producing a particular fibrous web, by the machines and methods for producing the same, and so forth.

The weight of the fibrous web of starting material may be varied within relatively wide limits above a predetermined minimum value, depending upon the requirements of the intermediate or the final products. A single, thin web of fibers, such as produced by a card, may have a weight of from about 35 to about 250 or more grains per square yard and may be used in the application of the principles of the present invention. Within the more commercial aspects of the present invention, however, web weights of from about 90 grains per square yard to about 800 grains per square yard are contempelated. If heavier web weights are desired, such as up to 2000 grains, for example, several of the individual webs may be combined into a laminated structure to obtain the desired weight. The product of one card may be folded, doubled, tripled, etc., on itself to reach the heavier weight, or a plurality of cards may be used and the individual products stacked or laminated for a similar purpose.

The binder areas 14 which bond or hold the nonwoven textile fabrics together may be in the form circles, annuli, rectangles, squares, diamonds, triangles, ellipses, ovals, or like rectilinear or curvilinear figures or other similar regular or irregular figures having over-all lengths and widths and areas of the same general order of magnitude. The size of the binder areas, regardless of their shape or configuration, should be maintained between about 0.00012 square inch and about 0.0028 square inch, and preferably from about 0.0008 square inch and about 0.0016 square inch.



The optimum spacing *c* between adjacent binder areas depends upon a number of factors such as the shape of the binder areas, their pattern arrangement in the nonwoven fabric, the nature of the binder material, etc. The particular pattern in which the binders are arranged in the fabric is of particular importance. Generally speaking, the spacing *c* between adjacent binder areas should be at least about .010 inch up to about 0.070 inch. Within the more specific aspects of the present invention, the spacing *c* between adjacent binder areas may be from about 0.015 inch up to about 0.050 inch.

It is to be clarified that the inter-binder area "spacing" distance *c* referred to herein is the distance from one edge of a binder area to the closest edge of the nearest binder area. It is not the center-to-center distance but the clear, unbonded edge-to-edge measurement between most-closely adjacent binder areas which is considered.

As a result primarily of such very small binder area sizes and secondarily because of such very small inter-binder area distances, the number of binder areas per unit area of nonwoven fabric soars to very large numbers. Within the broader aspects of the present invention, from about 120 to about 1100 binder areas per square inch has been found satisfactory. Within the preferred commercial aspects, from about 400 to about 700 binder areas per square inch has been found more desirable.

The binder area surface coverage is defined as the percentage of the total fabric surface which is covered by the binder areas. From about 7% to about 35% binder area surface coverage has been found applicable within the principles of the present invention. Within the more specific aspects thereof, from about 10% to about 30% has been found preferable.

The amount of binder add-on required to satisfactorily bond the nonwoven fabric and to provide the necessary strength to cooperate with the subsequent brushing step may range from about 2% to about 15% and preferably from about 4% to about 10%, by weight, based on the weight of dry fibrous web being bonded.

Th binder material itself which is employed to bond the nonwoven textile fabric together is a non-migratory binder, a representative example of such being a cellulosic binder, such as regenerated cellulose or hydroxyethyl cellulose, for example. By definition, a non-migratory binder is one which, when placed upon a nonwoven textile fabric, does not materially migrate or spread laterally into areas which have not been bonded with the particular binder. This resistance to lateral flooding is important in miniature bonding and it is essential that the binder selected be of the non-migratory type.

After the nonwoven fabric has been bonded with the predetermined miniature pattern of binder areas, the bonded nonwoven fabric is then brushed by being passed in contact with a rotating brushing wheel or similar device which lightly brushes either one or both sides of the nonwoven textile fabric whereby the fibers are caused to extend outwardly from the main body of the fabric to provide a high degree of softness thereto.

Such bonded and brushed nonwoven fabrics, when evaluated, are found to have sharply increased softness values and but only slightly decreased tensile strengths and are considered acceptable to the trade.

It has further been discovered that if the brushing is carried out in such a way that only a portion of the surface of the nonwoven fabric is brushed, the decrease in strength is even further minimized. Reference is made to FIGURE 3 wherein there is disclosed a method and apparatus for brushing the nonwoven fabric over only a portion of its surface.

In this figure, there is disclosed a fabric supply roll 20 mounted upon a rotatable shaft 22 and adapted to supply a sheet of nonwoven fabric F for processing, as de-

sired or required. The nonwoven fabric F passes under an adjustable guide rod or roll **24** and is then directed upwardly to pass between the nip of two horizontally corrugated rolls **26** and **28**, mounted on rotatable shafts **30** and **32**.

As disclosed, the horizontally corrugated roll **26** is adjustably mounted so that it is capable of movement toward or from its cooperating horizontally corrugated roll **28**. Pressure means **34** is provided in order that the horizontally corrugated roll **26** is pressed against and meshes and mates with the horizontally corrugated roll **28** with the crests of one corrugated surface nesting into the troughs of the other corrugated surface.

The spacing and depth of the corrugations in the horizontally corrugated rolls **26** and **28** is such that a nonwoven fabric which is passed therebetween is pressed down into the troughs of the corrugations by the crests of the mating corrugations so that a brushing roll **36** mounted on a rotatable shaft **38** passing in contact therewith, brushes only the areas of the nonwoven fabric passing over the crests or peaks of the corrugations and misses the nonwoven fabric deposited in the troughs of the corrugations. Reference is made to FIGURE 4 which shows in an enlarged scale the extent of the contact of the brush **36** with the nonwoven fabric F while positioned on the horizontally corrugated roll **28**.

As noted in FIGURE 4, the horizontally corrugated roll **28** is provided with a cylindrically corrugated sleeve or liner **29** which completely encases the roll **28**. The corrugations are formed in this liner **29** and replacements may be easily made by removing the liner and substituting for it another liner of a different shape and configuration of corrugations, as desired or required. The liner **29** is preferably made of a relatively soft, resilient material such as rubber, natural or synthetic, or polymeric plastic materials. A similar replaceable liner **27** is provided for the roll **26**.

In a similar way, the brushing roll **36** is provided with a cylindrically shaped sleeve or liner **37** having bristles or brushes **39**. The liner **37** may be removed and replaced by other liners with other brushes, when desired or required.

Horizontally corrugated roll **28** is fixed relatively whereas the brushing roll **36** is pivotally and adjustably mounted on a lever **40** mounted in the machine frame **42** and capable of being controllably adjusted by a turnscrew **44** or its equivalent. By such means, therefore, the brushing pressure may be increased or decreased, as desired.

After the nonwoven fabric has been brushed on the horizontally corrugated roll **28**, it passes downwardly around an idler or guide roll **46** mounted on a rotatable shaft **48**. The nonwoven fabric then passes upwardly and is positioned on a vertically corrugated roll **50** mounted on a rotatable shaft **52**.

As shown in FIGURE 5, a corrugated sleeve or liner **51** is provided on the roll **50** whereby the desired depth and spacing of corrugations is obtained. The liner **51** is, of course, removable whereby other corrugated forms and shapes may be used. The liner **51** is preferably made of synthetic or natural rubber, or polymeric plastic materials.

It is to be clarified that the term "horizontally corrugated roll" as used herein is intended to indicate a roll wherein the corrugations lie on the surface of the roll and have a direction parallel to the axis of the roll. The term "vertically corrugated roll" as used herein is intended to indicate a roll in which the corrugations are positioned around the surface of the roll as circumferences thereof.

The vertically corrugated roll **50** has its shaft **52** adjustably controlled by adjusting screw **54** whereby the pressure exerted by the vertically corrugated roll **50** and the brushing roll **36** on the nonwoven fabric F may be adjusted.



Again, it is to be noted that the brushing roll does not brush the entire surface of the nonwoven fabric but merely brushes it where it passes over the peaks of the corrugations, missing those portions which are in the troughs. If desired, a second vertically corrugated roll may be supplied to press the nonwoven fabric into the troughs of the corrugated roll **50**. Such pressing action would, of course, take place immediately prior to the brushing step.

Subsequent to the brushing of the nonwoven fabric on the vertically corrugated roll **50**, the bonded and brushed nonwoven fabric is directed forwardly and wound on a fabric take-off roll **56** mounted on a shaft **58**.

The invention will be further illustrated in greater detail by the following specific examples. It should be understood, however, that although these examples may describe in particular detail some of the more specific features of the invention, they are given primarily for purposes of illustration and the invention in its broader aspects is not to be construed as limited thereto.

In the examples that follow, reference is made to "long tensile strength" or "cross tensile strength." These strength characteristics of the fabric are determined by randomly cutting 4 test samples from the fabric which has been dried and the moisture reduced to equilibrium regain. The test samples are 1" x 6" in size, with the 1-inch dimension being in the fabric cross direction and the 6-inch dimension being in the fabric long direction. The samples of fabric are placed in the jaws of a Scott IP–4 tester, an instrument designed and manufactured specifically for determining the strength of a fabric by Scott Testers, Inc., of Providence, R.I. A force is then applied to each end of the sample until it breaks. That force is the long tensile strength. For nonwoven fabrics intended for use as covers for sanitary napkins and having weights in the range of from about 228 grains per square yard to about 252 grains per square yard, a minimum long tensile strength (dry) of 35 is permitted.

This procedure is repeated with 4 additional dry samples measuring 1" x 6" in size with the 1-inch dimension being in the long direction and the 6-inch dimension being in the cross direction. The samples are placed in the jaws of the Scott tester as before and the force required to break the fabric is the cross tensile strength. For nonwoven fabrics intended for use as covers for sanitary napkins as described above, a minimum cross tensile strength of 2.5 (dry) is permitted.

The softness or flexural rigidity of the nonwoven fabric is determined by cutting four 8½" square samples randomly from the test fabric. Each sample is then tested on a Thwing-Albert Handle-O-Meter, an instrument designed and manufactured by the Thwing-Albert Instrument Co. of Philadelphia, Pa., for testing the softness or flexural resistance of fabrics. A metal bar bends the fabric and the resistance to flex is determined in milliamperes, which is converted to a softness figure. For nonwoven fabrics intended for use as a cover for sanitary napkins as described above, a minimum softness rating of 81 (dry) is permitted.

*Example I*

A card web laminate weighing approximately 235 grains per square yard is formed by superimposing a plurality of 4 card webs. The fibers are 50% dull and 50% extra dull viscose rayon, 1 9/16 inches in length and having a denier of 1.5. The card web laminate is bonded with regenerated cellulose in an oval miniature pattern, the bonded nonwoven fabric weighing 244 grains per square yard. The percent binder is 3.8%, based on the weight of the dry fibers.

The pattern used comprises binder areas in the form of ovals having a cross axis of 0.053 inch and a long axis of 0.023 inch. The area of each oval is 0.00096 square inch. The binder coverage is 14.4%. The ovals extend across the nonwoven fabric at an angle of 45° to

the long direction thereof and are spaced from each other ten to the inch measured along one 45° angle. In this way the clear distance (tip to tip) is 0.070 inch, measured in the 45° direction. The ovals in the opposite 45° rows are offset or staggered similar to that shown in FIGURE 1. They are spaced fifteen to the inch measured along the other 45° angle. The interbinder distance as measured in the 45° direction is 0.0375 inch. There are 150 binder areas per square inch.

The long tensile strength of this fabric is determined to be 76 (passing); the cross tensile strength is 8 (passing); and the softness is 59 (failing), all evaluations being on a dry sample.

The miniature pattern bonded nonwoven fabric is then brushed with the apparatus disclosed in FIGURES 3, 4 and 5. The ratio of the linear surface velocity of brush to the surface speed of the nonwoven fabric is about 5:1. The brush is made of "fancy" wire clothing, in which the wires are spirally embedded in the foundation fabric.

The final properties of the miniature pattern bonded and brushed nonwoven fabric are: long tensile strength —45 (passing); cross tensile strength—3 (passing); and softness—83 (passing), all evaluations being on a dry sample. This nonwoven fabric passes all three tests and is acceptable as a cover for sanitary napkins.

*Example II*

A nonwoven fabric is prepared substantially as described in Example I except that conventional prior art multiannulate binder pattern such as described in U.S. Patent 2,705,688 is employed. In this non-miniature pattern, the outside diameter of the annulus is 0.16 inch; the inside diameter of the annulus is 0.003 inch; the amount of overlap is 0.04 inch; the center-to-center spacing between immediately adjacent rows of annuli as measured in the long direction is 0.22 inch; and the minimum interbinder spacing is 0.09 inch. The number of binder areas is 38 per square inch. The long tensile strength of this bonded nonwoven fabric is 60 (passing); the cross tensile strength is 6 (passing); and the softness is 65 (failing), all measurements being made on a dry fabric. This nonwoven fabric is then subjected to brushing substantially identical to the brushing employed in Example I. The bonded and brushed nonwoven fabric has a long tensile strength of 33 (failing); a cross tensile strength of 2.3 (failing); and a softness of 85 (passing), all measurements being dry. This nonwoven fabric, although it is rated excellent for softness, fails in 2 of the 3 required strength tests and is not suitable for use as a cover for a sanitary napkin.

*Example III*

The non-miniature pattern bonded nonwoven fabric described in Example II is brushed in a different way by being passed between an upper felt-covered roll and a lower driven brush and then between a lower felt-covered roll and an upper driven brush in such a way that the nonwoven fabric is lightly brushed on both surfaces. Basically, however, the brushing is substantially mechanically equivalent to the brushing of Example II.

Prior to brushing, the non-miniature pattern bonded nonwoven fabric has a long tensile strength of 60 (passing), a cross tensile strength of 6 (passing) and a softness of 65 (failing). Subsequent to brushing, the bonded and brushed nonwoven fabric has a long tensile strength of 31 (failing); a cross tensile strength of 2.1 (failing); and a softness of 85 (passing). All measurements are again taken on a dry fabric. The nonwoven fabric, although it rates very high in softness, fails two of the three required strength tests and is not suitable for use as a cover for sanitary napkins.

Although several specific examples of the inventive concept have been described, the same should not be construed as limited thereby nor to the specific features described therein but to include various other features of equivalent construction as set forth in the claims appended hereto. It is understood that any suitable changes, modifications and variations may be made without departing from the spirit and scope of the invention.

What is claimed is:

1. A method of continuously making a bonded, brushed nonwoven fabric wherein the surface fibers have been brushed and extend outwardly from the main body of the nonwoven fabric to provide a high degree of softness thereto, which comprises: bonding a layer of overlapping intersecting fibers with a non-migratory binder in a predetermined pattern of from about 120 to about 1100 binder areas per square inch, the average size of said binder areas being at least about 0.00012 square inch and not more than about 0.0028 square inch; continuously passing the bonded nonwoven fabric through a brushing zone; and during said passage continuously brushing said bonded nonwoven fabric across the entire width thereof substantially uniformly in selected predetermined areas to cause the fibers to extend outwardly from the main body of the nonwoven fabric a relatively short distance due to the large number and small size of said binder areas, whereby fabric softness is increased, fiber rupture is minimized, and the strength of the nonwoven fabric is not materially reduced.

2. A method of continuously making a bonded, brushed nonwoven fabric wherein the surface fibers have been brushed and extend outwardly from the main body of the nonwoven fabric to provide a high degree of softness thereto, which comprises: bonding a layer of overlapping intersecting fibers with from about 2% to about 15% by weight, based on the weight of the dry fibers, of a non-migratory regenerated cellulose binder in a predetermined pattern of from about 120 to about 1100 binder areas per square inch, the average size of said binder areas being at least about 0.00012 square inch and not more than about 0.0028 square inch; continuously passing the bonded nonwoven fabric through a brushing zone; and during said passage continuously brushing said bonded nonwoven fabric across the entire width thereof substantially uniformly in selected predetermined areas to cause the fibers to extend outwardly from the main body of the nonwoven fabric a relatively short distance due to the large number and small size of said binder areas, whereby fabric softness is increased, fiber rupture is minimized, and the strength of the non-woven fabric is not materially reduced.

3. Apparatus for making a bonded, brushed nonwoven fabric wherein the surface fibers have been brushed and extend outwardly from the main body of the nonwoven fabric to provide a high degree of softness thereto, which comprises: means for bonding a layer of overlapping intersecting fibers with a non-migratory binder in a predetermined pattern of from about 120 to about 1100 binder areas per square inch, the average size of said binder areas being at least about 0.00012 square inch and not more more than about 0.0028 square inch; means for forming said nonwoven fabric into a series of crests and troughs; and means for brushing only those portions of said bonded nonwoven fabric lying in said crests to cause the fibers to extend outwardly from the main body of the nonwoven fabric a relatively short distance due to the large number and small size of said binder areas, whereby fabric softness is increased, fiber rupture is minimized, and the strength of the nonwoven fabric is not materially reduced.

4. Apparatus for making a bonded, brushed nonwoven fabric wherein the surface fibers have been brushed and extend outwardly from the main body of the nonwoven fabric to provide a high degree of softness thereto, which comprises: means for bonding a layer of overlapping intersecting fibers with a non-migratory binder in a predetermined pattern of from about 120 to about 1100 binder areas per square inch, the average size of said binder areas being at least about 0.00012 square inch and not more than about 0.0028 square inch; means for continu-

ously passing the bonded nonwoven fabric through a brushing zone; and means for brushing said bonded nonwoven fabric across the entire width thereof substantially uniformly in selected predetermined areas to cause the fibers to extend outwardly from the main body of the nonwoven fabric a relatively short distance due to the large number and small size of said binder areas, whereby fabric softness is increased, fiber rupture is minimized,



and the strength of the nonwoven fabric is not materially reduced.

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