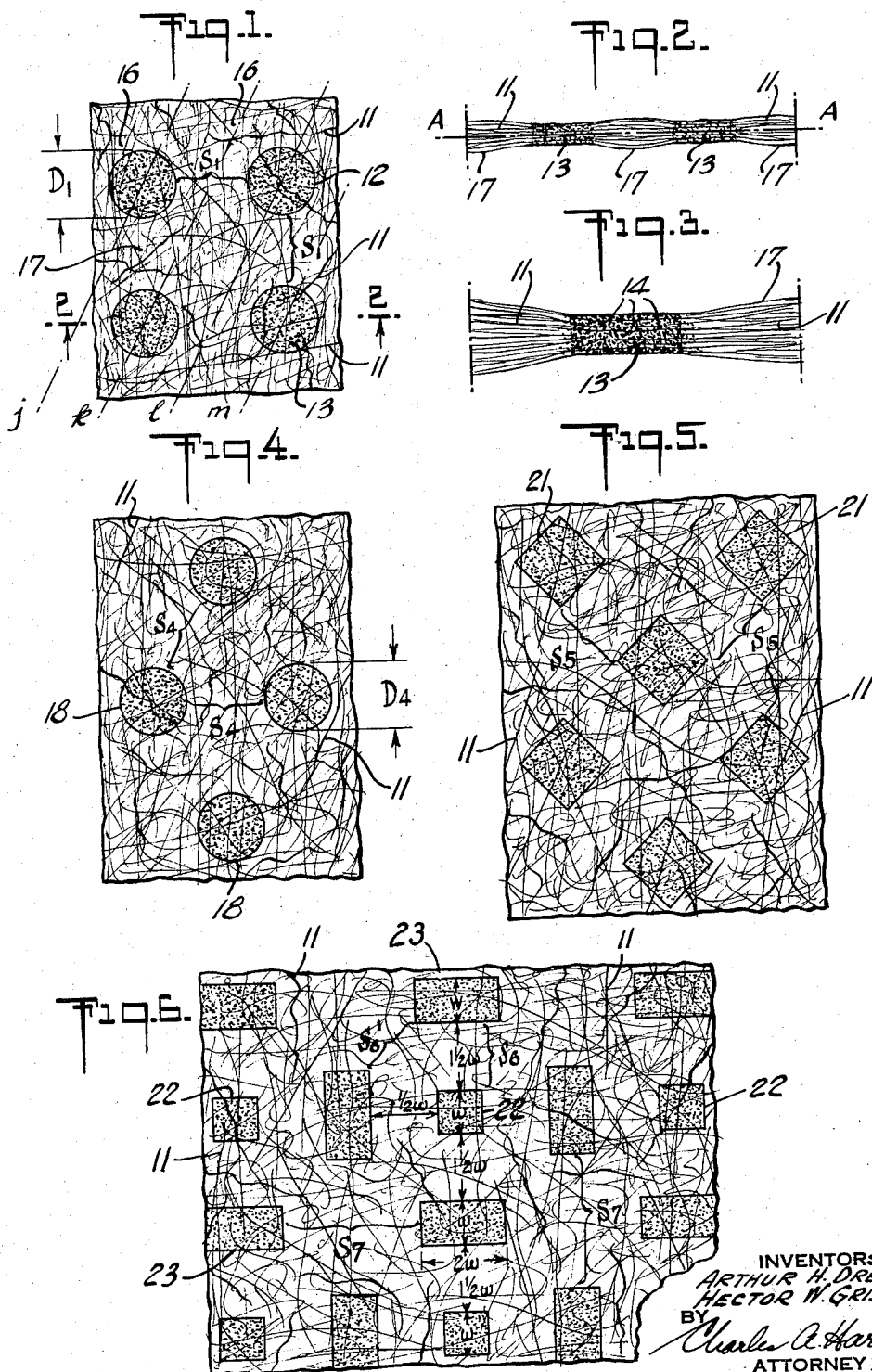


A. H. DRELICH ET AL
TEXTILE-LIKE NONWOVEN FABRIC

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TEXTILE-LIKE NONWOVEN FABRIC

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This invention relates to nonwoven fabrics, i.e., fabrics produced directly from fibers without the necessity for conventional spinning, weaving, knitting, or felting operations. More specifically, it is concerned with bonded nonwoven fabrics which possess textile-like hand and drape, and wherein the fibers are held together by an adhesive or bonding material distributed amongst them in a predetermined pattern.

Such fabrics conventionally are manufactured at the present time by producing a more or less tenuous web or layer of loosely associated fibers, preferably of textile length or over, using any one of a variety of well-known procedures or techniques and then distributing an adhesive material or the like in the layer in a predetermined pattern designed to adhere the individual fibers together while providing some measure of textile-like properties in the fabric. In general, webs or thin layers formed by carding, garnetting, air laying, papermaking methods, or the like, are bonded individually, or a plurality of such layers are laminated and then bonded.

Joshua Goldman Patent 2,039,312 discloses distributing an adhesive binder intermittently in a card web layer of textile fibers in zones such as spaced parallel strips, grids of intersecting strips, or the like, in such a way that the web area occupied by binder is only a small fraction of the total area of the web and the space between zones preferably is no less than one half the average fiber length of the material employed. According to Goldman, this results in substantially preserving the fibrous hand of the original unbonded layer of fibers. Unfortunately, however, with this spacing between binder zones, Goldman's fabric has a tendency to fail under wet abrasion and is not suitable for laundering.

Esther Goldman in Patent 2,545,952 sought to improve the strength of a nonwoven fabric made from a carded web by applying a binder in closely spaced areas over at least 50 percent, preferably at least 60 percent, of the total surface area of the web. This fabric, due to the number and size of the binder areas and the high surface coverage specified, is substantially devoid of the fibrous textile-like hand of the original web. Instead, it is relatively stiff and harsh, lacking softness and absorbency.

Fabrics according to both of the aforementioned Goldman Patents are intermittently bonded in the sense that the binder is distributed in spaced areas thereof. In Esther Goldman Patent 2,545,952 the binder is distributed in spaced discrete areas which are discontinuous, while in Joshua Goldman Patent 2,039,312, the binder is distributed in spaced strips and in intersecting strips. The recent patents in the name of Ness, Lints, and/or Petterson, Nos. 2,705,686, 2,705,687, and 2,705,688 are directed to fabrics which are intermittently bonded. The Ness et al. patents disclose fabrics of carded webs which, through pattern bonding, combine softness and absorbency with appreciable strength, flexibility, and lateral extensibility, albeit they make no provision for launderability.

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Thus, although the prior art discloses nonwoven fabrics which are strong, on the one hand, or relatively soft, on the other, and may have improved lateral extensibility, no nonwoven fabric of the character herein described has been proposed which is strong and fully launderable and also textile-like in nature. For this reason, nonwoven fabrics have not been particularly adapted for use in clothing in general, or in other applications where both washability and softness are prerequisites.

We have invented an intermittently bonded nonwoven fabric which surprisingly possesses washability and improved strength, as well as textile-like softness and drape, and therefore is adapted for use as a lining material for clothing, particularly where such materials may be worn next to the skin, for inner and outer wear in general, for washable towels, napkins, tablecloths, handkerchiefs, and the like, sanitary napkins, surgical dressings, draperies, curtains, reusable industrial fabrics, as well as in a variety of other applications where this unusual combination of properties is important. This fabric comprises a web or layer of relatively loosely assembled overlapping and intersecting fibers extending in a plurality of diverse directions generally parallel to the major plane of the fabric and a multiplicity of relatively small bonds closely spaced parallel to said plane in accordance with a predetermined pattern. Preferably, the fibers are relatively soft and flexible and in the order of normal textile length, although shorter fibers may be used, as will be described more fully hereinafter. The desired textile-like softness and drape is obtained by preserving as much as possible of the softness and drape of the fibrous layer as it existed before bonding.

Textile-like softness and drape in fabrics are qualities which are well-known and recognized by those skilled in the art and even by consumers, but have not as yet been reduced to satisfactory quantitative measurement. In general, nonwoven fabrics of the character herein described possessing these qualities are soft, drapable, pleasant to handle and without palpable roughness due to the intermittent bonds.

In general, by washability as used herein is meant the ability of the fabric to withstand washing by modern techniques without serious effects on its appearance or strength. A single cycle wash in a modern horizontal tumbler washer, such as a Bendix home washer, may be used as a test for this purpose, although at least two or three or even more washes are preferred. Prior art nonwoven fabrics which do not possess washability may fail by breaking off of fibers between bonds or by the splitting or disintegration of the bonds themselves, with the result that the fabrics no longer have utility for their intended purpose. This particularly is true of fabrics comprising fibers of absorbent materials such as viscose rayon, which weaken considerably when wet.

We have determined that an important element affecting washability is the closeness of the spacing between bonds. In order to achieve washability in an intermittently bonded fabric of this type, the binder containing areas should be spaced quite close to one another.

We also have determined that to preserve the fibrous softness and drape of the original fibrous web, or its absorbency if this quality is important, the proportion of binder to fiber should be maintained low enough to allow the fibers to predominate in determining these characteristics. For the purposes of this application, the proportion of binder to fiber may be expressed in terms of the percentage of the total surface of the fabric which is covered by the binder containing areas, or binder area surface coverage. It also is important from a standpoint of softness that the distances or spaces between the binder containing areas are great enough to prevent adjacent

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binder areas from cooperating and behaving like a continuous or over-all bond.

In accordance with this invention, a washable bonding material is distributed according to a predetermined pattern in a multiplicity of very small closely spaced areas of the fabric. These areas are sufficiently small, much smaller than previously has been suggested for intermittently bonded fabrics, that they can be spaced close enough to one another to achieve washability while maintaining the binder surface coverage low enough to allow the fibers to predominate in determining the softness and absorbency of the fabric. On the other hand, the binder areas are large enough to provide sufficient binder to anchor the fibers securely enough for washability when they are spaced from one another sufficiently to prevent the bonds from cooperating and behaving like an over-all impregnation bond. Advantageously, the binder areas also are maintained sufficiently small to prevent them from being felt as individual bonds or separate "islands" of bonding material when the fabric is crinkled and worked between the fingers, for instance.

The binder containing areas may be in the form of circles, squares, like rectilinear or curvilinear figures or other similar regular or irregular figures having over-all lengths and widths of the same general order of magnitude. If they are circular, for instance, it is preferred that the diameter of the individual binder areas be at least about 0.010 inch and not more than about 0.045 inch, corresponding roughly to areas of 0.00008 square inch, and 0.0016 square inch, respectively. Optimum results for certain type binders, particularly those which may be printed in the web in the form of an aqueous dispersion may be obtained with binder areas ranging between about 0.020 and 0.045 inch in diameter corresponding roughly to areas of 0.0003 square inch to 0.0016 square inch. However, since many factors affect the efficacy of the bonding system according to this invention, including the shape of the binder areas, their arrangement in the fabric, the nature of the binder material itself, the way in which the binder is applied and bonds are formed with the fibers, to mention a few, critical limits for binder area size may vary somewhat with changes in these factors. Circular binder areas as small as about 0.004 inch in diameter, corresponding roughly to an area of 0.000012 square inch or smaller, may be satisfactory under certain conditions, while areas as large as 0.060 inch in diameter, corresponding roughly to an area of 0.0028 square inch, or somewhat larger, may be advantageous under other conditions. The size of the binder containing areas, regardless of their shape should be maintained between about 0.000012 and 0.0028 square inch, under most conditions.

The optimum spacing between adjacent binder areas also depends upon a number of factors such as those mentioned above in connection with binder area size. The pattern in which the binder areas are arranged in the fabric is of particular importance. Generally speaking, it is preferred that the spacing between adjacent binder containing areas be at least about 0.015 inch and not more than about 0.050 inch, although spacing as low as about 0.010 inch, or somewhat lower, and as high as about 0.060 inch, or even higher, may be advantageous under certain conditions.

Binder area surface coverage may range as high as about 35 percent or as low as about 7 percent. However, in general, it is preferred that the binder containing areas cover at least about 12 percent and not more than about 30 percent of the total surface area of the fabric.

In general, within the ranges specified above, for binder area size and spacing, greater spacing is preferred between larger areas and lesser spacing is preferred between smaller areas. Allowance has been made for this relationship in the ranges specified for binder area surface coverage. However, even within the ranges specified for surface coverage, best results may be obtained

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by adjusting the size and spacing of the binder areas to achieve an optimum relationship. This relationship should be consistent with the shape of the areas and the patterns in which they are arranged as well as their size and spacing.

A bonding material or binder having appreciable water resistance is desirable to assure that it will withstand washing when applied to the fabric in accordance with this invention. Additionally, the binder should be chosen to form strong bonds with the fibers employed, as well as itself possessing good tensile properties and film forming ability. The binder in the individual binder areas may be particulate or solid, or in the form of partially solid porous masses such as might be formed by printing a resin in melt form or fusing a mass of particles under controlled conditions of temperature and pressure. When the binder is predominately particulate, the particles within the binder areas should be close enough to one another to assure that the fibers passing through each area are held together to act with the binder as a single unit.

Particulate binder areas may be formed by printing an aqueous dispersion of a resinous adhesive in spaced areas of the web or layer, as is well-known in the art, or by printing an adhesive in solution by similar techniques. Particulate binder areas also may be formed by depositing dry binder particles in spaced areas of the web and then fusing them to an adhesive or bonding condition to form bonds as generally is described in copending application Serial No. 420,301, filed in the name of Harmon and Plummer on April 1, 1954, now Patent No. 2,820,716, granted January 21, 1958, as well as by various other methods.

The fibrous layer, itself, may be formed by any one of a number of conventional techniques for depositing or arranging fibers in a web or layer. 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 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 structure.

In order to provide this open structure of overlapping, intersecting fibers, relatively long textile-like fibers above normal papermaking lengths, of close to normal textile length, say about $\frac{1}{4}$ inch to 2 inches or longer, are preferred, although shorter fibers, as for example, certain papermaking fibers, somewhat below $\frac{1}{4}$ inch in length, may be used, particularly if they are mixed with longer fibers. It is preferred that the shorter papermaking fibers be unbeaten or substantially unhydrated to provide a textile-like fabric.

The invention may be illustrated further by reference to the attached drawings, wherein:

Fig. 1 is a greatly enlarged schematic plan view of a portion of a nonwoven fabric according to one embodiment of this invention.

Fig. 2 is a schematic sectional view roughly along the line 2—2 of Fig. 1.

Fig. 3 is an even more greatly enlarged schematic view of one of the bonds of Fig. 2.

Fig. 4 is a greatly enlarged schematic plan view of a portion of a different nonwoven fabric according to this invention.

Fig. 5 is a similar plan view of a portion of still another fabric according to this invention.

Fig. 6 is a like schematic plan view of a portion of a fabric according to still a different embodiment of the invention.

Referring to Figs. 1—3 there is shown a fabric comprising a layer of overlapping and intersecting fibers which are bonded or held together by a particulate bonding material distributed according to a predetermined pattern in spaced areas of the fabric. The binder areas,

themselves, are substantially circular, having a diameter D_1 between about 0.004 and 0.06 inch, corresponding to the hereinbefore referred to size range for the binder containing areas. The circular binder areas 12 are arranged in a square pattern of intersecting parallel rows. Thus, the spacing S_1 between adjacent binder areas is the same as the spacing between the parallel binder areas is the same as the spacing between the parallel rows. The spacing S_1 should fall within the range of about 0.01 to 0.06 inch referred to hereinbefore for spacing between adjacent binder areas. This pattern and bond spacing is particularly suitable for bonding an isotropic fibrous layer, i.e., a layer in which the fibers extend in all directions parallel to the major plane of the fabric without being oriented in one direction to any particular extent.

The bonds 13 formed by particles 14 in each of the binder areas 12 extend through the thickness of the fabric substantially from one surface to the other, as shown in Figs. 2 and 3. While the spacing of the individual particles 14 within the bonds depends to a certain extent upon the concentration of the particles in the medium in which they are applied, as for example, the percent solids in an aqueous dispersion, in general deposition is controlled so that the particles are arranged closely enough to assure that those portions of the fibers passing through each bond 13 are secured to one another to act with the binder as a single unit. For instance, as shown particularly in Fig. 3, the particles 14 may be spaced quite closely and uniformly throughout the lateral extent of the bond.

The bonds 13 are spaced in the major plane of the fabric A—A and at the same general level in the fabric with respect to this plane. Also, as shown particularly in Fig. 2, the fibers 11 lie in positions which are generally flat or parallel to the major plane of the fabric. As shown in Fig. 1, the fibers 11 extend in a plurality of diverse directions in the planes where they lie. This would be true whether or not the fibers in the layer of Fig. 1 are predominately oriented in one direction, as in a card web, or whether they have no particular orientation, as in a random web. The fibers are relatively loosely assembled parallel to the major plane of the fabric, forming myriad openings or interstices 16 between them as shown roughly in Fig. 1, and are relatively closely assembled through the thickness of the fabric, i.e., overlapping and lying on top of one another, roughly as shown in Figs. 2 and 3.

Those portions of the fibers 11 passing through the bonds 13 are held by the binder in relatively compacted positions with respect to the thickness of the fabric, while the fiber segments between bonds generally are less compacted in this direction, providing a multiplicity of fibrous pillows or fluffy web areas 17 which preserve the softness of the fabric and tend to give it a quilted texture. This effect may be achieved by compacting the web bonding, either to apply binder, or to improve bond formation. The fiber containing bonds will remain compacted to a large extent while the fiber segments in the web areas between bonds will tend to spring back to their original positions after pressure is removed.

In the fabric of Fig. 4, a particulate binder is arranged in similar circular binder containing areas 18 which are arranged in the fabric in a diamond pattern as on the points of contiguous equilateral triangles. In this fabric the fibers 11 are oriented predominately in one direction, vertically in Fig. 4, and the diamonds of the binder pattern are arranged with their long axes extending in this direction. This binder pattern and its arrangement with respect to the predominate orientation of the fibers in the fabric is particularly suitable for bonding an oriented web of this type. The problems which exist in bonding oriented webs are discussed at great length in the aforementioned Ness et al. Patent 2,705,688 which stresses the advisability of overlap between contiguous columns of binder areas which extend in the direction of fiber orientation. In fabrics wherein the binder areas and the

spaces between them both are quite small, it is not so important to have overlap providing that the binder areas are arranged in such a way that there is little chance of fibers wending their way through the fabric without intersecting several binder areas. In this connection, on the average, each fiber should be bonded at least about 2 or 3 times along its length, preferably more often. In Fig. 4, the spacing S_4 between adjacent binder areas should not be much greater than the diameter D_4 of the areas themselves, thereby assuring that fibers extending in the vertical direction of this figure would find it difficult to pass through the fabric without intersecting several of the binder areas. It should be noted that the fibers 11 in the fabric of Fig. 4 are far from being exactly straight. It is very difficult to obtain a fibrous layer suitable for forming into a fabric in accordance with this invention, by carding or otherwise, wherein the fibers generally are not curled, kinked, and lying in relatively sinuous positions to some extent. Thus, when the binder areas and the spaces between them are relatively small, as in Fig. 4, wherein the diameter D_4 of the binder areas and the space S_4 between adjacent binder areas both lie within the ranges discussed above in connection with Fig. 1, the likelihood of these curled, kinked or sinuous fibers passing through the layer without intersecting several binder areas 18 is much less than for a fabric wherein the binder areas are spaced on a gross scale.

In Fig. 5 there is shown a fabric wherein fibers 11 are oriented predominately in a vertical direction, and square binder areas 21 are arranged in a square pattern of intersecting parallel rows which are disposed on the bias to the predominate direction of fiber orientation. Preferably, the size of the individual binder areas 21 lies between about 0.000012 and 0.0028 square inch, while the space between adjacent areas S_5 is maintained between about 0.01 and 0.06 inch. As in Fig. 5, it is apparent that there is little chance for the fibers 11 which extend predominately in the vertical direction of this figure to pass through the fabric without intersecting several of the binder areas 21.

Referring again to Fig. 1 and this time assuming the fibers are oriented predominately in the direction of the inclined lines j , k , l , and m , or at roughly 24° to the vertical direction of this figure, the four binder areas 12, shown, now lie in four separate columns parallel to the direction of orientation along the same lines j , k , l , and m . It is again apparent that it will be quite difficult for the oriented fibers to pass through the fabric without intersecting several of the binder areas 12 in this tilted square pattern.

In Fig. 6 the binder is arranged in a somewhat different pattern, which, like that of Fig. 1, is particularly suitable for bonding a substantially isotropic layer of fibers 11. In this figure the binder is arranged in small square areas 22 and somewhat larger rectangular areas 23, both of which preferably are maintained between about 0.000012 and 0.0028 square inch in size. Since the distances S_6 and S_6' between adjacent binder areas are roughly the same and appear to represent the least spacing between areas, neither should be less than about 0.01 inch. On the other hand, since the greatest spacing between adjacent binder areas appears to be represented by the distance S_7 , this distance S_7 should be maintained below about 0.06 inch in accordance with the criteria defined hereinbefore.

The following are offered as further examples of fabrics according to this invention.

Example I

A card web laminate weighing approximately 180 grains/sq. yd. is formed by superimposing a plurality of card webs, each weighing about 45 grains/sq. yd. and comprising $1\frac{1}{8}$ inch, 1.5 denier dull viscose rayon fibers. An aqueous dispersion of plasticized polyvinyl acetate containing 5 percent by weight of urea formaldehyde plus

catalyst is printed onto the web in a tilted square pattern inclined at 24° to the major direction of orientation of the fibers such as described above in connection with Fig. 1. The binder may be printed by techniques such as are described in the aforementioned Joshua Goldman Patent 2,039,312 or the Ness et al. Patent 2,705,686, or by other conventional methods. The bonds are substantially circular and approximately .020 inch in diameter and spaced from one another by 0.020 inch in a square pattern similar to that shown in Fig. 1. The fabric then is dried and cured by conventional techniques. The binder pick-up is approximately 11 percent by weight of the dry fibers, while binder areas surface coverage is about 9 percent. The resulting fabric has textile-like properties, is strong, and capable of being washed in a modern automatic drum washing machine without appreciable loss of fibers, appearance, or strength.

Example II

Quantities of 1.5 denier viscose rayon fibers averaging about 2 inches in length are dispersed in an air stream and collected on a foraminous member by any one of a number of known methods to form a fibrous layer weighing approximately 500 grains/sq. yd. The layer is bonded by printing as in Example I, an 8 percent solution of polyvinyl chloride in methyl ethyl ketone onto the web in a square pattern of .045 inch diameter binder areas spaced 0.040 inch from one another, edge to edge. The binder pick-up is 8 percent by weight of solids and the binder area surface coverage approximately 25 percent. The resulting fabric has softness, absorbency, strength, durability, and is washable in a conventional automatic home washer without harmful effects on its appearance or strength.

Example III

A web or layer of fibers consisting of about 50 percent, 1.5 denier, $\frac{3}{8}$ inch viscose rayon fibers, 30 percent of substantially nonhydrated alpha woodpulp, and 20 percent, 3 denier, $\frac{1}{2}$ inch cellulose acetate fibers is formed on a paper machine wire after mixing the fibers together and dispersing them in water. The web is bonded by printing in accordance with the foregoing examples a 15 percent solution of 99 percent hydrolyzed polyvinyl alcohol (Du Pont Evanol 71-30), plus 30 percent by weight of the alcohol of dimethylol urea, in a bond pattern consisting of circular areas 0.015 inch in diameter spaced 0.015 inch from adjacent bonds in a square pattern. The fabric is dried and cured by conventional techniques. The total binder pick-up is approximately 7 percent and the total binder area surface coverage is about 20 percent. The resulting fabric has textile properties for many uses and is washable in a conventional automatic home washer without serious distortion or loss of strength.

Example IV

A 350 grain/sq. yd. web of $\frac{1}{2}$ inch, 1.5 denier, viscose rayon fibers is formed as in Example III and bonded by printing using the same pattern arrangement but with areas .020 inch in diameter and spaced .020 inch apart. The bonding resin employed is sold by General Mills as Polyamide #94. This resin is heated until it flows and can be doctored onto an engraved printing roll. The total resin pick-up is 25 percent of the fiber weight and the resin bonds cover about 20 percent of the total fabric surface. This fabric is durable, strong, washable, and flexible and has adequate textile properties for many uses.

Example V

A carded web is formed weighing about 400 grains/sq. yd. and consisting of 60 percent of 2 inch, $1\frac{1}{2}$ denier, rayon fibers, 15 percent of one inch, $1\frac{1}{2}$ denier, cotton fibers, and 25 percent of $2\frac{1}{2}$ inch, 3 denier, nylon fibers. This web is bonded by sifting on to it, in the pattern of Fig. 4, wherein D_4 equals approximately 0.032 inch

and S_4 equals about 0.035 inch, vinyl chloride powder which then is treated under moderate pressure at a temperature of 370° F. to fuse the powder and form durable bonds. The bonding powder is applied in accordance with the techniques disclosed in Harmon and Plummer copending application Serial No. 420,301. The total binder pick-up is about 30 percent and the binder area surface coverage is approximately 18 percent. This fabric is strong, durable, flexible, washable, and soft, and can be used and reused in many textile and other applications.

Example VI

Using the method of Example III, 75 percent bleached high alpha woodpulp is blended with 25 percent of $\frac{3}{8}$ inch, 1.5 denier, viscose rayon fibers and formed into a web weighing about 350 grains/sq. yd. This web is print bonded with a resin consisting of polyvinyl acetate plus 10 percent dimethylol urea, plus catalyst, and then dried and cured. The resin is applied in a pattern of areas or dots 0.015 inch in diameter, spaced 0.015 inch apart in a square pattern tilted at 24° to the axis of the web, such as is described herein in connection with Fig. 1. The total resin pick-up is 20 percent and the binder area surface coverage also is about 20 percent. This fabric, while it may be relatively stiff compared to those of the previous example, is washable, durable, and suitably flexible and soft for many textile uses.

There are any number of binder materials which may be used to bond fibers into a fabric according to this invention. For instance, they may include various forms of polyvinyl acetate and copolymers, polyvinyl chloride and copolymers, copolymers of butadiene with acrylonitrile and/or styrene, and the like, which may be applied to the fibers as moderately plasticized aqueous dispersions; in the case of polyvinyl acetate and polyvinyl chloride, preferably with a small amount of a thermosetting resin included to insure wet strength. Copolymers of polyvinyl acetate with modifiers such as certain lower alkyl acrylates may be applied in the same manner. Binders which may be applied in solution include polyvinyl chloride, polyurethane, certain epoxy resins, polyvinyl alcohol in company with a wet strength resin such as dimethylol urea, and the like. Binder which may be applied in hot melt form such as polyethylene, certain polyamides, etc., also may be employed, as well as those which may be applied to the web in powder form and then fused to bond its fibers together, which include ethyl cellulose, nylon, polyvinyl chloride, polyvinyl butyral, polyvinyl formal, cellulose acetate, and the like.

Generally speaking, fibers of almost any material may be used for structural purposes in forming fabrics according to this invention. However, relatively flexible fibers are preferred. Fibers possessing particular qualities may be employed to contribute the same or related properties to the resulting fabric. For instance, relatively absorbent fibers are preferred when a fabric possessing high absorbency is desired. Natural fibers of animal or vegetable origin and artificial fibers whether of materials such as regenerated cellulose or true synthetics such as nylon or the like, may be employed. Fibers of cellulosic materials, such as viscose rayon, cotton, wood and the like, may be used, although as suggested hereinbefore, the wood fibers should be relatively long and substantially unhydrated for best results.

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, modifications, applications, and extensions of the basic principles involved may be made without departing from its spirit and scope. Thus, the fabrics of the present invention may be employed in a host of ways that will be readily apparent to the skilled artisan and many other

fibers and binder materials in addition to those specifically listed above may be used. We therefore intend to be limited only in accordance with the appended patent claims.

The claims are:

1. A soft washable nonwoven fabric comprising a layer of overlapping, intersecting fibers lying in positions generally parallel to the major plane of the fabric, and extending in a plurality of diverse directions parallel to said plane, said fibers predominately being at least about $\frac{1}{4}$ inch in length, and a binder material distributed in a multiplicity of very small closely spaced areas of the layer in bonding relation with the fibers passing through these areas, the average size of said areas being at least about 0.000012 square inch and not more than about 0.0028 square inch, and said areas covering between about 7 and 35 percent of the total surface area of the fabric and being arranged in accordance with a predetermined pattern in which adjacent areas are spaced from one another by not less than about 0.01 inch and not more than about 0.06 inch, the fibers being relatively compacted with respect to the thickness of the fabric where they pass through said binder areas and less compacted in this direction between said areas.

2. A soft washable nonwoven fabric comprising a layer of overlapping, intersecting fibers lying in positions generally parallel to the major plane of the fabric and extending in a plurality of diverse directions parallel to said plane, said fibers predominately being at least about $\frac{1}{4}$ inch in length, and a binder material distributed in a multiplicity of very small closely spaced areas of the layer in bonding relation with the fibers passing through these areas, the average size of said areas being at least about 0.000012 square inch and not more than about 0.0028 inch, and said areas covering between about 7 and 35 percent of the total surface area of the fabric and being arranged in accordance with a predetermined pattern in which adjacent areas are spaced from one another by not less than about 0.01 inch and not more than about 0.06 inch, the binder material in said areas extending substantially through the thickness of the fabric, the fibers being relatively compacted with respect to the thickness of the fabric where they pass through said binder areas and less compacted in this direction between said areas.

3. A soft washable nonwoven fabric comprising a layer of overlapping, intersecting fibers lying in positions generally parallel to the major plane of the fabric and extending in a plurality of diverse directions parallel to said plane, and a binder material distributed in a multiplicity of very small closely spaced areas of the layer in bonding relation with the fibers passing through these areas, the average size of said areas being at least about 0.000012 square inch and not more than about 0.0028 square inch, said areas covering between about 7 and 35 percent of the total surface area of the fabric and being arranged in accordance with a predetermined pattern in which adjacent areas are spaced from one another by not less than about 0.01 inch and not more than about 0.06 inch, the fibers being relatively compacted with respect to the thickness of the fabric where they pass through said binder areas and less compacted in this direction between said areas.

4. A soft washable nonwoven fabric comprising a layer of flexible textile-like fibers lying in positions generally parallel to the major plane of the fabric, overlapping and intersecting one another and extending in a plurality of diverse directions parallel to said plane, and a binder material distributed in a multiplicity of very small closely spaced areas of the layer in bonding relation with the fibers passing through these areas, the average size of said areas being at least about 0.000012 square inch and not more than about 0.0028 square inch, and said areas covering between about 7 and 35 percent of the total surface area of the fabric and being arranged

in accordance with a predetermined pattern in which adjacent areas are spaced from one another by not less than about 0.01 inch and not more than about 0.06 inch.

5. A soft washable nonwoven fabric comprising a layer of flexible textile-like fibers lying in positions generally parallel to the major plane of the fabric, overlapping and intersecting one another and extending in a plurality of diverse directions parallel to said plane, said fibers predominately being at least about $\frac{1}{4}$ inch in length, at least a majority of said fibers being relatively absorbent, and a binder material distributed in a multiplicity of very small closely spaced areas of the layer in bonding relation with the fibers passing through these areas, the average size of said areas being at least about 0.000012 square inch, and not more than about 0.0028 square inch, and said areas covering between about 7 and 35 percent of the total surface area of the fabric and being arranged in accordance with a predetermined pattern in which adjacent areas are spaced from one another by not less than about 0.01 inch and not more than about 0.06 inch, the fibers being relatively closely assembled through the thickness of the fabric and relatively loosely assembled parallel to the major plane of the fabric forming myriad small interstices between them.

6. A soft washable nonwoven fabric comprising a layer of viscose rayon fibers lying in positions generally parallel to the major plane of the fabric, overlapping and intersecting one another and extending in a plurality of diverse directions parallel to said plane, and a binder material distributed in a multiplicity of very small closely spaced areas of the layer in bonding relation with the fibers passing through these areas, the average size of said areas being at least about 0.000012 square inch and not more than about 0.0028 square inch, and said areas covering between about 7 and 35 percent of the total surface area of the fabric and being arranged in accordance with a predetermined pattern in which adjacent areas are spaced from one another by not less than about 0.01 inch and not more than about 0.06 inch, the fibers being relatively closely assembled through the thickness of the fabric and relatively loosely assembled parallel to the major plane of the fabric forming myriad small interstices between them.

7. A soft washable nonwoven fabric comprising a layer of overlapping, intersecting fibers and a water resistant binder material distributed in a multiplicity of very small closely spaced areas of the layer in bonding relation with the fibers passing through the areas, said fibers predominately being at least about $\frac{1}{4}$ inch in length, said areas being arranged in accordance with a predetermined pattern in which adjacent areas are spaced from one another by not less than about 0.01 inch and not more than about 0.06 inch, the average size of said areas being at least about 0.000012 square inch and not more than about 0.0028 square inch, the proportion of binder to fiber being high enough to provide washability and low enough to assure a high degree of the softness and absorbency of the fibrous layer itself.

8. A soft washable nonwoven fabric as defined in claim 7 wherein the fibers are cotton and the binder material is cellulosic.

9. A soft washable nonwoven fabric as defined in claim 7 wherein the fibers are cellulosic.

10. A soft washable nonwoven fabric as defined in claim 9 wherein the binder material is cellulosic.

11. A soft washable nonwoven fabric as defined in claim 7 wherein the fibers are nylon.

12. A soft washable nonwoven fabric as defined in claim 11 wherein the binder material is a polyamide.

13. A washable nonwoven fibrous layer comprising overlapping, intersecting fibers and a water resistant binder material distributed in a multiplicity of very small closely spaced areas of the layer in bonding relation with the fibers passing through the areas, said areas being arranged in accordance with a predetermined pat-

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tern in which adjacent areas are spaced from one another by not less than about 0.01 inch and not more than about 0.06 inch, the average size of said areas being at least about 0.000012 square inch and not more than about 0.0028 square inch, said areas covering between about 7 and 35 percent of the total surface area of the layer.

14. A washable nonwoven fibrous layer comprising overlapping, intersecting fibers and a water resistant binder material distributed in a multiplicity of very small closely spaced areas of the layer in bonding relation with the fibers passing through the areas, said areas being substantially circular and arranged in accordance with a predetermined pattern in which adjacent areas are spaced from one another by not less than about 0.01 inch and not more than about 0.06 inch, the average size of said areas being at least about 0.000012 square inch and not more than about 0.0028 square inch, said areas covering between about 7 and 35 percent of the total surface area of the layer.

15. A washable nonwoven fibrous layer comprising overlapping, intersecting fibers and a water resistant binder material distributed in a multiplicity of very small closely spaced areas of the layer in bonding relation with the fibers passing through the areas, said areas being substantially circular and arranged in accordance with a predetermined pattern in which adjacent areas are spaced from one another by not less than about 0.01 inch and not more than about 0.06 inch, the average diameter of said areas being at least about 0.004 inch and not more than about 0.06 inch, said areas covering between about 7 and 35 percent of the total surface area of the layer.

16. A washable nonwoven fibrous layer comprising overlapping, intersecting fibers and a water resistant binder material distributed in a multiplicity of very small closely spaced areas of the layer in bonding relation with the fibers passing through the areas, said areas being arranged in accordance with a predetermined pattern in which adjacent areas are spaced from one another by not less than about 0.01 inch and not more than about 0.06 inch in such a way that on the average every fiber intersects

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at least about 2 or 3 binder areas, the average size of said areas being at least about 0.000012 square inch and not more than about 0.0028 square inch, said areas covering between about 7 and 35 percent of the total surface area of the layer.

17. A washable nonwoven fibrous layer comprising overlapping, intersecting fibers and a water resistant binder material distributed in a multiplicity of very small closely spaced areas of the layer in bonding relation with the fibers passing through the areas, said areas being arranged in accordance with a predetermined pattern in which adjacent areas are spaced from one another by not less than about 0.015 inch and not more than about 0.05 inch, the average size of said areas being at least about 0.00008 square inch and not more than about 0.0016 square inch, said areas covering between about 12 and 30 percent of the total surface area of the layer.

18. A washable nonwoven fibrous layer comprising overlapping, intersecting fibers and a water resistant binder material distributed in a multiplicity of very small closely spaced areas of the layer in bonding relation with the fibers passing through the areas, said areas being substantially circular and arranged in accordance with a predetermined pattern in which adjacent areas are spaced from one another by not less than about 0.015 inch and not more than about 0.05 inch, the average diameter of said areas being at least about 0.01 inch and not more than about 0.045 inch, said areas covering between about 12 and 30 percent of the total surface area of the layer.

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