March 20, 1951 E. R. GOLDMAN 2,545,952

UNWOVEN FLEXIBLE FABRIC

Filed Oct. 18, 1946 3 Sheets-Sheet 1

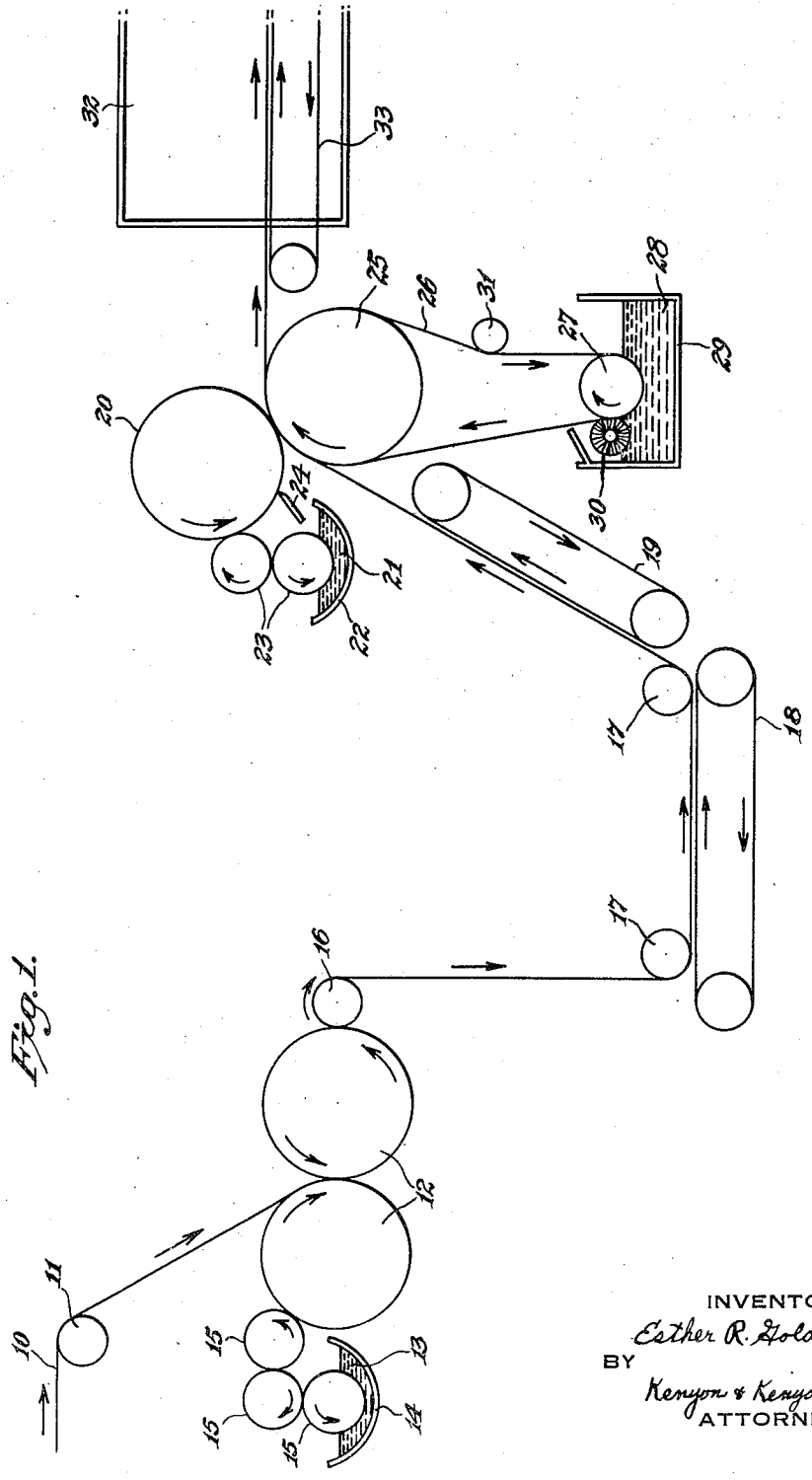

Fig. 1.

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Fig. 2.

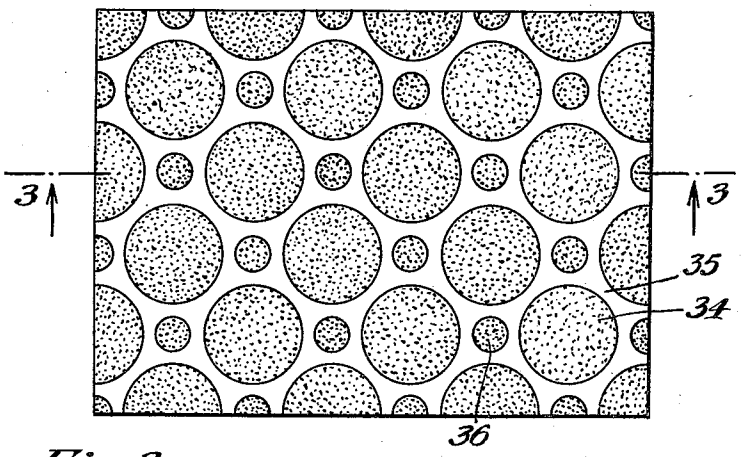

Fig. 3.

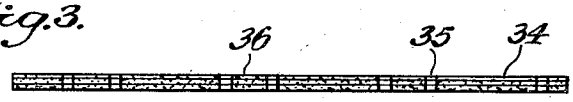

Fig. 4.

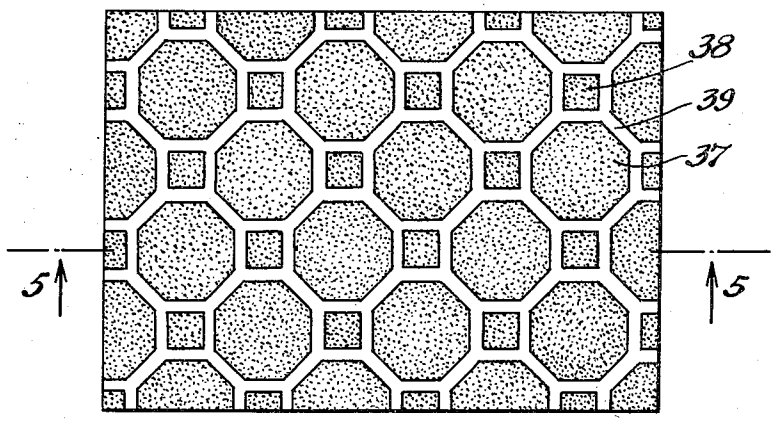

Fig. 5.

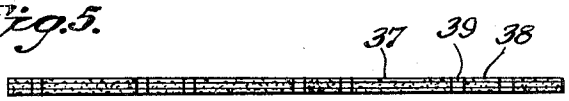

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Fig. 6.

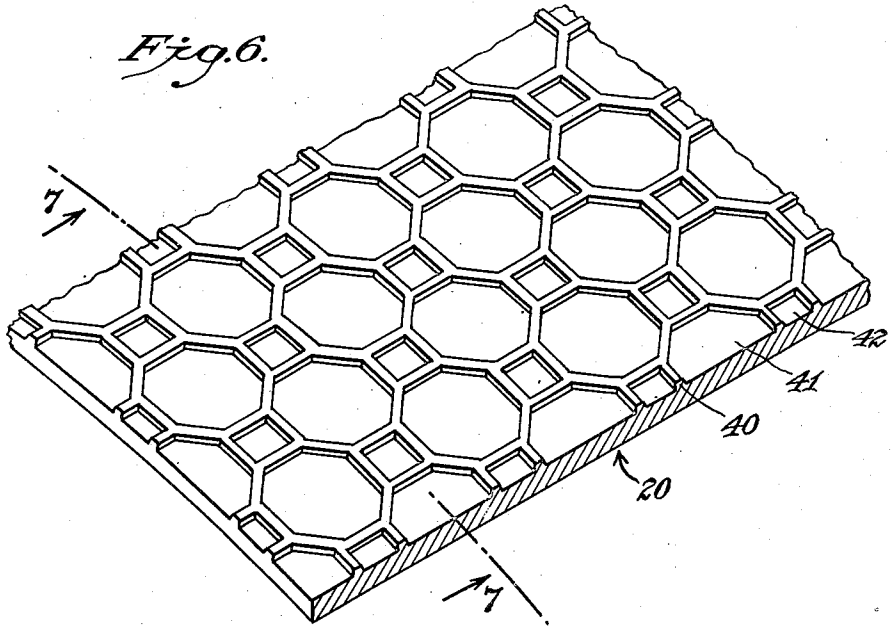


Fig. 7.

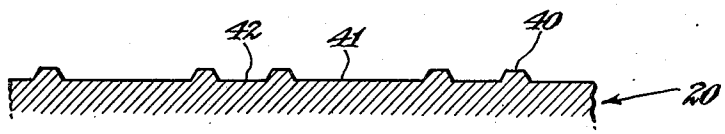


Fig. 8.

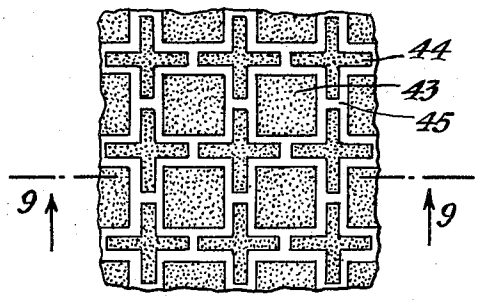
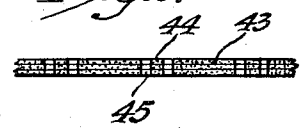


Fig. 9.



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UNITED STATES PATENT OFFICE

2,545,952

UNWOVEN FLEXIBLE FABRIC

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Application October 18, 1946, Serial No. 704,009

11 Claims. (Cl. 154—46)

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This invention relates to fabrics and the manufacture thereof. It relates especially to fabrics wherein the fibers are unspun, namely, wherein the fibers are disposed in sheet form without having been subjected to operations such as spinning or weaving.

Unspun fibers which are disposed in sheet form and which are essentially free from binder, afford fabrics that are extremely fragile. For example, cotton produced in sheet form by carding has very little strength. In a sheet of carded cotton fibers, the fibers are loosely matted in a fleece-like condition and have a certain degree of machine orientation due to the action of the carding machine on the fibers, although many of the fibers are hooked-shaped due to the action of the pins of the carding machine and although the fibers as a group extend in diverse directions which accounts for the fact that a carded fiber sheet has a slight degree of tensile strength and is capable of considerable stretching in any direction. Such carded cotton fleece-like sheets have been used in their inherently weak and absorptive condition either as originally taken from the carding machine or as bonded lightly with a material such as starch. Such sheet materials are, however, entirely too fragile to be used for the purposes for which most fabrics are intended.

The fleece-like product that results from the carding of cotton has also been utilized in the manufacture of products such as imitation leather, imitation boards, etc., by impregnating throughout a fibrous body of desired thickness with some resinous binder. Such products, are, however, relatively stiff and "boardy" and may vary from a product that is leather-like to one which is quite rigid and board-like depending on the nature and quantity of the resin used and the thickness and state of compression of the fibrous material as a whole.

It is a purpose of this invention to provide a fabric of unspun fibers such as carded cotton fibers that has adequate strength for many purposes for which woven fabrics are now used exclusively and that has strength comparable to woven fabrics. It is a further purpose of this invention to afford attractive appearing fabrics which are flexible and have adequate strength and which can be produced at a much lower cost than conventional woven fabrics.

I have found that sheets of unspun fibers which inherently have very little tensile strength can be converted by a simple and inexpensive operation into a fabric which has adequate tensile strength for a large number of purposes and

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which at the same time is flexible and pliable, being similar in these respects to woven fabrics. The accomplishment of these purposes results from the application of binder material to a sheet of unspun fibers in a special way. It is a principal feature of this invention that the binder is applied to the sheet of unspun fibers in the form of what are described and illustrated herein as "spots." However, such spots cannot be applied haphazardly but must, in order to attain the results contemplated according to this invention, be applied so as to conform to certain predetermined relationships. Thus I have found that the spots should be spaced from each other so as to be essentially independent. The proportion of the total surface area of the sheet occupied by the spots should be at least 50% and preferably should be at least 60%. While the proportion of the total surface area occupied by the spots should be 50% or greater, the individual spots have to be quite small, namely of the order of 0.004 to 0.06 square inch in area, with the result that the fibrous sheet has a multiplicity of the small spots distributed about the lateral extent thereof. In ordinary practice the individual spots preferably are from about 0.01 to about 0.05 square inch in area. The individual spots, while spaced from each other, are disposed in immediately adjacent relationship, the spaces between adjacent spots being of the order of 0.01 to 0.06 inch and preferably being about 0.02 to about 0.04 inch. The spaces between the spots may vary in width somewhat depending upon the shape of the individual spots and the pattern in which they are arranged. In view of this fact certain portions of the spaces between the spots may depart somewhat from the limits stated, although the average spacing should be of the order stated. If the spots that are selected are within the lower position of the size range above mentioned, the spacing between the spots also tends to be correspondingly small due to the requirement that the spots occupy at least 50% of the surface area of the sheet.

The binder that is applied to form the individual spots may be any binder that is appropriate for binding fibers together. For example, any natural or synthetic resin may be employed such as phenol-aldehyde or phenol-urea resins. Polymerized vinyl compounds are likewise suitable. Substances such as cellulose acetate, cellulose nitrate and the like are likewise suitable. Bitumens are suitable for many purposes. Casein, glue and the like, preferably treated for water insolubilization can be used. The binder is ap-

plied preferably so as to strike through the sheet of unspun fibers and so that the fibers at each of the individual spots are firmly cobonded. Usually the binder is applied in a solvent thinned condition, namely a normally hard or tough binder material is dissolved in a suitable solvent therefor to reduce the binder to a fluid or semi-fluid consistency appropriate for impregnating the sheet without, however, feathering sidewardly to an excessive degree so that the spots will run together. After the solvent thinned binder has been applied, it can be hardened by drying to remove the solvent. If the binder is of the thermosetting type, the ultimate hardening can be accomplished by applying sufficient heat to induce this setting reaction. If the binder is thermoplastic the binder can, if desired, be brought to the proper consistency for application merely by heating the binder. In such case the binder, after application, will harden merely as a result of cooling. The binder that is ultimately deposited on the fibers may be hard and rigid, and it is one of the advantages of this invention that a highly flexible fabric can be made using a binder that is normally hard and rigid and of a type that affords maximum cobonding of the fibers. However, a binder which is not rigid but which has some degree of flexibility may be employed such as rubber or such as a plasticized resin.

A fabric made as above described resembles a conventional woven fabric in several respects. At each of the spots where the binder is applied, the fibers are bonded together, but since the individual spots are small, each individual spot is not noticeable as such in handling the fabric even though each individual spot per se is hard and rigid. The presence of the multiplicity of adjacent spaced spots does, however, impart good tensile strength to the fabric, for the spaces between the spots, being small, are bridged by the fibers which are anchored to the opposite sides of the individual spaces. Moreover, since the regions of the spaces between the spots are deficient in binder as compared with the spots, the fibers at the regions of such spaces can be readily flexed; and since such regions are distributed over the lateral extent of the sheet material in closely spaced relation, the fabric as a whole has good over-all flexibility and pliability as well as good tensile strength. Moreover, the individual spots and spaces therebetween, being small, merge together as far as general appearance and physical properties are concerned so as to impart to the fabric a textured effect. If the binder that is used is essentially colorless, and is employed with an essentially white fiber such as bleached cotton fibers, an essentially white fabric can be obtained which in general appearance can be made to resemble a variety of effects produced by special weaves in the case of woven fabrics. If the binder that is used is colored, and the fibers are white or are of a color different from the color of the binder, pleasing effects can be obtained in the form of a fine design running throughout the fabric, the nature of the design being variable as desired depending upon the shape of the individual spots and upon the pattern in which they are applied. Of course, if the binder is inherently colored the fibers can be dyed to the same color, or can be otherwise matched as to color, so as to obtain a colored fabric of essentially the same color throughout.

In preferred embodiments of this invention, the binder spots are applied to the sheet of unspun fibers so that the spaces between the spots are not in alignment along a line extending in any direction along the lateral extent of the sheet. The normal tendency in applying a multiplicity of spots arranged in a geometrical pattern is to provide an over-all pattern wherein the spaces between the spots fall in alignment along a line extending in at least one direction along the sheet or even in two or more directions. I have found, however, that by arranging the spots so that the spaces between the spots do not occur in alignment in any direction along the lateral extent of the sheet, the strength characteristics of the sheet material are rendered more uniform and I have likewise found that the tear strength can be very materially improved. While this result can be obtained in several different ways it is usually desirable to provide a first pattern of spots arranged in predetermined adjacent spaced relation and then provide a second pattern of spots which fall in predetermined relation with respect to the spots constituting the first pattern so that the spots of the second pattern lie athwart any line along the sheet occupied by aligned spaces between the spots of the first pattern. This will be illustrated hereinbelow in connection with specific embodiments of this invention shown in the drawings.

It has been mentioned hereinabove that this invention is well adapted for the manufacture of fabrics from carded cotton fibers. The cotton fibers used for this purpose are such that the major proportion by weight of the fibers is ¼ inch or greater in length. Such fiber is referred to herein as "long" fiber in order to distinguish from the "short" paper making grades of wood fiber, rag fiber, etc., the bulk of which runs from $\frac{1}{16}$ to ¼ inch in length. In the practice of this invention "long" fibers, as above defined, should be employed. It is not essential, however, that the fibers that are used be cotton fibers. Thus any "long" fibers that can be brought into sheet form in an unspun condition may be employed. Thus synthetic fibers such as cellulose acetate, rayon, proteinous fibers, etc., may be employed. Vegetable fibers such as wood fibers liberated so as to be in long condition may be used, as well as hemp, ramie, flax, etc. Animal fibers, particularly wool or silk, are suitable. Mineral fibers such as asbestos, glass fibers, mineral wool, slag wool and the like may likewise be employed. Unspinnable fibers such as kapok, milkweed fibers, Spanish-moss, etc., may likewise be employed. Suitable mixtures of fibers may be employed. Ordinarily, however, for flexible fabrics resembling in flexibility the flexibility of the more common woven textile fabrics, it is desirable to employ flexible fibers, the term "flexible" fiber being intended to refer to fibers which are at least as flexible as a good grade of Tampico fibers.

The sheet material, wherein the fibers are disposed in unspun relation, may be produced in any of a variety of different ways. For fibers such as cotton it is convenient to employ a carding machine, for the fibers as oriented by the action of a carding machine are well suited for manufacture into flexible fabrics according to this invention. Garnetting may likewise be employed. If desired, in forming the sheet, the fibers may be brought into increased degrees of parallelism and straightness in one direction, as compared with carding or garnetting, by operations such as drafting or combing. In the case of sheet material such as carded cotton, the sheet material has little strength in any direction, but

due to the action of the carding machine on the fibers the carded sheet has somewhat greater strength in the machine direction than across the sheet. When, however, such sheet material has binder applied in the form of the closely adjacent spaced small spots according to this invention, the sheet material is notable for its strength not only in the machine direction of the sheet, but also across. The strength across the sheet is due to the fact that the fibers are held in position wherever the binder spots occur, while the narrow intervening spaces permit slight movement of the fibers between the spots so as to bring them under a tensile load regardless of the direction of the tensile stress applied to the sheet. A carded sheet bonded according to this invention has slightly less "give" in the machine direction than it has transversely, but the ultimate tensile strength is good in both directions. The foregoing is likewise applicable even in the case of sheet materials wherein the fibers have been brought largely into parallelism as by drafting or combing the unspun fibers of the sheet material. If desired, however, two or more relatively thin sheets or webs, e. g., of straightened fibers lying in parallelism, may be cross-laid so that the preponderant fiber direction in the different sheets or webs is in such different predetermined directions as may be desired, e. g., at 90° to each other, and this invention may be practiced in connection with sheets of unspun fibers of this character.

In the case of fibers which are somewhat longer and stiffer than cotton, rayon, etc., the unspun fibers can be disposed in sheet form by other machines appropriate for handling such fibers, e. g., a gill box, a draw box or the like. In the manufacture of flexible fabrics according to this invention, it is preferable to employ webs or sheets of unspun fibers weighing from about ½ ounce to about 6 ounces per square yard. The size of the individual binder spots can advantageously be adjusted within the limits above mentioned, depending upon the thickness of the sheet of unspun fibers, it being preferable to employ relatively small binder spots in the case of thin sheets and to employ larger binder spots in the case of thicker sheets.

Ordinarily, the sheet of unspun fibers to which the binder spots are applied is essentially free of binder so that the regions of the spaces between the spots will have maximum flexibility. However, it is not essential that the spaces between the binder spots be absolutely free of all binder material. Thus, it is frequently convenient, especially in the case of combed or drawn webs which are even more fragile than carded webs, to apply a small amount of starch to the unspun fibrous sheet so as to facilitate the handling of the sheet in the operations incident to converting the sheet into a strong flexible fabric according to this invention. The presence of such starch is not inconsistent with the subsequent application of the binder spots or with the obtainment of a fabric having a high degree of flexibility according to this invention. If desired, a light application of some binder other than starch may be employed either before or after the application of the binder spots. Such binder may be incidental to producing desired effects such as prevention of linting, acquiring water-repellance, acquiring increased resistance to moisture, rotting, fire, vermin, etc., as the case may be. Accordingly, it is not essential that the regions of the spaces between the binder

spots be essentially binder-free but merely that the fibers in these regions be capable of flexure and of affording over-all flexibility of the finished sheet material. Such flexibility is indicative of capacity of the sheet to be bent back on itself over its own thickness without rupture. Normally in the regions of the spaces between the binder spots, any binder that is present is less than half the amount by weight of binder at the binder spots.

Further purposes, features and advantages of this invention will be apparent from the following description of certain specific embodiments of this invention which are described hereinbelow for purposes of exemplication and which are shown in the accompanying drawings, wherein

Fig. 1 is a side elevation, largely schematic, of one form of apparatus appropriate for the manufacture of fabrics embodying this invention,

Fig. 2 is a plan view on an enlarged scale of a portion of one form of fabric embodying this invention showing the arrangement of spots where binder material serves to bond together the unspun fibers of the sheet,

Fig. 3 is a sectional elevation of the fabric shown in Fig. 2 on the line **3—3** of Fig. 2,

Fig. 4 is a plan view of an alternative embodiment of this invention on the same scale as Fig. 3,

Fig. 5 is a sectional elevation of the fabric shown in Fig. 4 taken on the line **5—5** of Fig. 4,

Fig. 6 is a perspective view on an enlarged scale of a portion of the surface of a printing roll for application of a binder to form spots arranged in the pattern shown in Figs. 4 and 5,

Fig. 7 is a sectional elevation of the surface portion of the printing roll shown in Fig. 6 taken on the line **7—7** of Fig. 6,

Fig. 8 is a plan view on an enlarged scale of an alternative embodiment of fabric embodying this invention, and

Fig. 9 is a sectional elevation of the fabric shown in Fig. 8 taken on the line **9—9** of Fig. 8.

With reference to the manufacture of fabrics embodying this invention, apparatus such as that illustrated schematically in Fig. 1 has been found to be convenient and suitable for the purpose, although it is obvious that many other arrangements of apparatus are suitable for the manufacture of my new fabrics. Appropriate mechanisms, not shown, may be employed to operate the mechanisms in the directions indicated by the arrows.

While it is not essential to do so, it is normally preferable to preliminarily wet out the sheet material before the binder is applied, since by preliminarily wetting the fabric it has been found that the binder when applied tends to strike through the fabric to better advantage. The device shown in Fig. 1 includes means for preliminarily wetting out the sheet of unspun fibers before the binder is applied thereto.

The sheet material **10**, which is to be converted into fabric according to this invention and which is in the form of carded cotton or other sheet of unspun fibers is introduced into the apparatus shown in Fig. 1 over the guide roll **11** and then proceeds to the wetting out rolls **12**. It is the function of these rolls to moisten the web material with a liquid which facilitates the binder impregnation step that follows. For example, if the binder is a substance such as casein, which is applied in an aqueous solution, the fabric may

be preliminarily wetted out with water. If, on the other hand, the binder is a resinous material, it is usually thinned with a non-aqueous solvent which can be used to preliminarily wet out the fabric. More generally any liquid which is miscible with the binder material applied can be used to wet out the fabric. The liquid used to preliminarily wet out the fabric is applied by the rolls 12 so as to moisten the sheet material. The liquid 13 is contained in the receptacle 14 and is transferred to the surface of one of the rolls 12 by the transfer rolls 15. These transfer rolls can be adjusted so as to apply to the surface of the roll 12 the predetermined desired amount of liquid for preliminarily moistening the sheet material. The moistened sheet material is stripped from one of the rolls 12 by the stripping roll 16. The moistened sheet material is then passed under the guide rolls 17 and is supported by the conveyor belts 18 and 19 while being directed to the engraved roll 20 which applies binder to the web material in the form of a multiplicity of spots as has been described more in detail hereinabove. The desired binder 21, which may, for example, be a phenol-aldehyde resin thinned to a semi-fluid consistency by a solvent such as alcohol, is contained in the receptacle 22 and is transferred to the surface of the roll 20 by the transfer rolls 23. Preferably, the engraved roll 20 is of the intaglio type so that the binder which is to be transferred to the fabric is carried in predetermined amount in recesses in the surface of the roll. However, other printing mechanisms for application of the binder spots may be employed. In order to confine the binder to the recesses, when an intaglio type roll is used, a scraper 24 is provided which is adapted to wipe clean the portions of the surface of the roll 20 which are not in the form of recesses filled with the binder material. The engraved roll 20 is arranged to operate in pressure contact with the backing apron 26 which rides over and moves with the surface of the roll 25. The backing apron 26 has two functions. One of these functions is to afford a resilient backing against which the engraved roll 20 can be pressed so as to force the sheet material as it passes between the rolls 20 and 25 into the recesses in the engraved roll 20 and thereby drive the binder contained in the recesses in the surface of the roll 20 throughout the thickness of the sheet material. The backing apron 26 is also of advantage in that it affords a simple means for providing a surface against which the engraved roll 20 can be pressed and which can be conveniently cleaned so that a clean surface may be brought into contact with the sheet material during the binder application step. In printing the sheet material, the binder strikes through and comes in contact with the surface opposite the engraved roll. If the binder were to accumulate on this surface, the regions of the spaces between the spots would receive binder material contrary to the intent of preserving the flexibility of these regions. As shown in the drawing, the apron 26 is caused to travel over the roll 27 so as to be submerged in a bath of cleansing liquid 28 in the container 29. For example, the cleansing liquid may be a solvent for the binder. A rotatable brush 30 is preferably provided so as to positively remove any binder which may remain adherent to the backing apron. In order to control the tension of the backing apron, a guide roll 31 may be provided.

After the fabric has been impregnated so as to provide a multiplicity of spots over the lateral extent of the fabric and extending through the fabric, the sheet material with the binder applied thereto may be introduced into the drier 32, a conveyor 33 being used to support the sheet material as its passes through the drier. After the binder has become hardened as a result of drying or as a result of some other action such as thermo-setting, the essential elements of the fabric have been produced. It is, of course, possible to subject the fabric to further treatments as may be desired. For example, the binder that has been applied may be subjected to a treatment adapted to decrease its solubility in water or a thermo-setting binder may be heated to accomplish setting of the binder. If desired, the fabric may be subjected to various finishing treatments such as dyeing, bleaching or the like.

In order to illustrate a typical pattern of spots which is appropriate for use according to this invention and which the engraved roll 20 shown in Fig. 1 is adapted to apply, reference is made to Figs. 2 and 3. The pattern shown in Figs. 2 and 3 may be applied, for example, to a carded cotton sheet weighing about 900 grains per square yard. The binder that is applied to the sheet material is applied in the form of a multiplicity of circular spots. These spots are of two sizes. The larger spots 34 are disposed in immediately adjacent spaced relation throughout the lateral extent of the sheet material. The binder is indicated by stippling in Fig. 3 and extends throughout the thickness of the sheet material fibers. The spaces between the spots where the binder is applied are indicated by the reference character 35. A fabric wherein the binder is applied merely at the location of the large circles 34 constitutes a fabric which embodies this invention even though the binder is not applied in the form of the smaller circular spots 36, provided the areas of the larger circular spots 34 is sufficient to constitute over 50% of the lateral extent of the sheet material. Such a fabric has very substantial tensile strength and at the same time is highly flexible.

It is preferable according to this invention to employ the smaller circular binder spots 36 in order to improve the tensile strength characteristics of the fabric and in order to improve its tear strength. It is to be noted that the spaces between the larger circles 34 lie in alignment in two directions of the sheet material. By utilizing the binder at the regions of the smaller circular spots 36, the smaller circular spots 36 lie athwart the lines of alignment of the spaces between the larger circular spots 34. In other words, the larger circular spots 34 constitute a first predetermined pattern of adjacent spaced spots and the smaller circles constitute a second pattern of spots in predetermined relation with respect to the spots constituting the first pattern so as to lie athwart any line along the sheet occupied by aligned spaces between the spots of the first pattern. A staggered arrangement such as that shown in Figs. 2 and 3 is usually convenient for accomplishing this purpose.

As pointed out above, the pattern illustrated in Figs. 2 and 3 is shown on an enlarged scale. For accomplishing the purposes of this invention in commercial production and for purposes of affording a specific example, the diameter of the larger spots 34 may advantageously be 0.15 inch and the diameter of the smaller circles 36 may advantageously be about 0.047 inch. The centers of the adjacent small and large circles are separated about ⅛ inch which results in the spaces

between the adjacent spots being approximately 0.025 inch in width. The total area of the binder spots is about 60% of the lateral extent of the sheet. The binder that is applied, even though it may be a rigid binder such as a phenol-aldehyde resin, does not impart stiffness to the fabric although it is effective in imparting high tensile strength. This is because of the size and relative positions of the spots. Moreover, due to the size and relative positions of the spots, the fabric handles very similarly to conventional woven fabrics and a very desirable fabric is afforded at a cost which is only a small fraction of the cost of producing woven fabrics.

In Figs. 4 and 5, an alternative pattern of binder spots is illustrated. This pattern is generally similar to that shown in Figs. 2 and 3 except that in lieu of the larger circular spots 34, octagonal spots 37 are employed. Instead of the smaller circular spots 36 of Figs. 2 and 3, squares 38 are employed in the pattern of Figs. 4 and 5. The spaces between the spots 37 and 38 are indicated by the reference character 39. Using the pattern of Figs. 4 and 5, the width of the spaces 39 between the binder spots can be made more uniform throughout and the total area occupied by the spaces can be reduced. When the dimensions of the spots of the pattern shown in Figs. 4 and 5 are essentially the same as the dimensions of the spots of the pattern shown in Figs. 2 and 3, the area of the sheet occupied by the spots 37 and 38 is substantially 64% of the total area of the sheet material.

For purposes of illustrating the surface of an engraved roll adapted to effect spot bonding of a sheet of unspun fibers according to this invention, a portion of the surface of an engraved roll suitable for producing the pattern of the embodiment of this invention shown in Figs. 4 and 5 is shown in Figs. 6 and 7. This roll may, for example, be the roll 20 shown in Fig. 1 and the reference character 20 has been applied generally to the portion of the roll shown in Figs. 6 and 7. The roll surface has binder-carrying areas separated by the lands 40. The larger binder-carrying areas 41 are adapted to produce the octagonal spots 37 shown in Figs. 4 and 5. The smaller binder-carrying areas 42 are adapted to provide the smaller square-shaped spots 38 shown in Figs. 4 and 5. The lands 40 produce the binder-free spaces 39 shown in Figs. 4 and 5. For impregnating sheets of carded cotton or the like, the upper surface of the lands 40 may project above the bottom of the binder-carrying areas 41 and 42 to the extent of about 0.01 inch. In using the roll, the roll surface is covered with the binder composition to be applied so as to fill all of the binder-carrying areas on the roll which are in the form of recesses. The lands are then wiped clean and thereafter the sheet of unspun fibers is forced against the surface of the engraved roll. The relatively fragile, absorptive and compressible sheet of unspun fibers is forced into the binder-carrying recesses so that the binder composition strikes into and through the sheet of unspun fibers. At the same time, the lands compress the sheet of unspun fibers so as to minimize lateral feathering of the binder composition into the portions of the web of unspun fibers in contact with the lands thereby causing the binder to occur in the sheet in the form of essentially independent spaced spots. When the depth of the recesses in the surface of the rolls is of the order above stated, it has been found that an adequate supply of the binder composition is provided for impregnating the sheet of unspun fibers in the regions of the spots without depositing an excess of the binder composition, which, if present, would spread laterally and cause the spots to merge with each other. The binder composition that is applied to the roll preferably is not excessively thin and watery, but is of a somewhat viscous consistency analagous to printing ink or the like. When the binder composition is of such consistency, it can be readily forced into and through the sheet of unspun fibers, but is resistant to excessive lateral spreading by capillary action into the spaces between the spots after the binder composition has been applied. If some lateral feathering of the applied binder should occur, this can be counteracted by making the lands slightly wider than the spacing between the spots that is desired in the finished fabric.

For purposes of further illustration, an alternative design for spot bonding sheets of unspun fibers according to this invention is illustrated in Figs. 8 and 9. According to the embodiment of this invention shown in Figs. 8 and 9, a pattern of square-shaped spots 43 is provided. In staggered relation thereto, the cross-shaped spots 44 are provided. It is to be noted that the cross-shaped spots 44 lie athwart the lines of aligned spaces between the square-shaped spots 43. The spaces 45 between the spots 43 and 44 are deficient in binder and preferably are essentially free from binder so as to provide the over-all flexibility, as has been described hereinabove. The dimensions of the spots shown in Figs. 8 and 9 may be of the order indicated above, namely, the individual square-shaped spots 43 may be about 0.04 square inch in area and the spaces between these spots and the cross-shaped spots 44 may be about 0.02 inch.

It is apparent from the foregoing that it is possible according to this invention to produce inexpensive fabrics from sheets of unspun fibers which fabrics not only have adequate strength for a large number of purposes, but also have flexibility comparable to the flexibility of woven textiles. Products made according to this invention are suitable for a number of purposes such as inexpensive sheet material for tablecloths, curtains, blankets and the like. Flexible fabrics of attractive appearance can be produced. Fabrics produced according to this invention likewise can be used for other purposes such as interliners for luggage, articles of wearing apparel, etc. When the fabric is to be used for an interliner, it is, of course, the case that the appearance is of lesser concern and the binder and arrangement of binder spots can be selected primarily from the utilitarian point of view in providing fabrics of desired weight, strength and flexibility.

While this invention has been described in connection with certain typical examples of the practice thereof, it is to be understood that this has been done merely for purposes of exemplification and that the practice of this invention is subject to considerable variation within the scope thereof as defined by the language of the following claims.

I claim:

1. As an article of manufacture, a flexible fabric of unspun long fibers disposed in the form of a sheet, said fibers being spot bonded to impart to said sheet tensile strength in all directions by a multiplicity of essentially independent adjacent spaced spots of binder impregnating

and cobonding the fibers of said sheet, said spots occupying a major proportion of the lateral extent of said sheet, being individually of the order of 0.004 to 0.06 square inch in area and being spaced apart by a distance of the order of 0.01 to 0.06 inch, the fibers of said sheet in the spaces between said spots being capable of flexure and affording over-all flexibility of said sheet.

2. As an article of manufacture, a flexible fabric of unspun long fibers disposed in the form of a sheet, said fibers being spot bonded to impart to said sheet tensile strength in all directions by a multiplicity of essentially independent adjacent spaced spots of binder impregnating and cobonding the fibers of said sheet, said spots occupying a major proportion of the lateral extent of said sheet, being individually of the order of 0.004 to 0.06 square inch in area and being spaced apart by a distance of the order of 0.01 to 0.06 inch, the fibers of said sheet in the spaces between said spots being capable of flexure and affording over-all flexibility of said sheet, and said spots being arranged with certain of said spots lying athwart any line along said sheet occupied by aligned spaces between other of said spots.

3. As an article of manufacture, a flexible fabric of unspun long fibers disposed in the form of a sheet, said fibers being spot bonded to impart to said sheet tensile strength in all directions by a multiplicity of essentially independent adjacent spaced spots of binder impregnating and cobonding the fibers of said sheet, said spots occupying a major proportion of the lateral extent of said sheet, being individually of the order of 0.004 to 0.06 square inch in area and being spaced apart by a distance of the order of 0.01 to 0.06 inch, the fibers of said sheet in the spaces between said spots being capable of flexure and affording over-all flexibility of said sheet, said spots comprising a first pattern of spots arranged in predetermined adjacent relation and a second pattern of spots arranged in predetermined relation with respect to the spots constituting said first pattern and disposed athwart any line along said sheet occupied by aligned spaces between the spots of said first pattern.

4. As an article of manufacture, a flexible fabric of machine oriented cotton fibers a major proportion by weight of which is ¼ inch or greater in length and which are disposed in the form of a sheet, said fibers being spot bonded to impart to said sheet tensile strength in all directions by a multiplicity of essentially independent adjacent spaced spots of binder impregnating and cobonding the fibers of said sheet, said spots occupying a major proportion of the lateral extent of said sheet, being individually of the order of 0.004 to 0.06 square inch and being spaced apart by a distance of the order of 0.01 to 0.06 inch, the fibers of said sheet in the spaces between said spots being capable of flexure and affording over-all flexibility of said sheet.

5. As an article of manufacture, a flexible fabric according to claim 4 wherein the fibers of said sheet in the spaces between said spots are substantially free of binder.

6. As an article of manufacture, a flexible fabric according to claim 4 wherein said spots are arranged with certain of said spots lying athwart any line along said sheet occupied by aligned spaces between other of said spots.

7. As an article of manufacture, a flexible fabric of carded long cotton fibers disposed in the form of a sheet, said fibers being spot bonded to impart to said sheet tensile strength in all directions by a multiplicity of adjacent spaced spots of binder impregnating and cobonding the fibers of said sheet, said spots occupying a major proportion of the lateral extent of said sheet, being individually of the order of 0.01 to 0.05 square inch and being spaced apart by a distance of the order of 0.02 to 0.04 inch, the fibers of said sheet in the spaces between said spots having substantially the flexibility of binder free fibers.

8. As an article of manufacture, a flexible fabric according to claim 7 wherein certain of said spots are arranged in a predetermined pattern in adjacent relation and wherein other spots are arranged in staggered relation with respect to the spots of said pattern and so as to lie athwart any line along said sheet occupied by aligned spaces between the spots constituting said pattern.

9. As an article of manufacture, a flexible fabric of unspun long fibers disposed in the form of a sheet, said fibers being spot bonded at a multiplicity of essentially independent adjacent spaced spots to impart to said sheet tensile strength in all directions, said spots occupying a major proportion of the lateral extent of said sheet, being individually of the order of 0.01 to 0.06 square inch in area and being spaced apart by a distance of the order of 0.01 to 0.06 inch, the fibers of said sheet in the spaces between said spots being capable of flexure and affording over-all flexibility of said sheet.

10. As an article of manufacture, a flexible fabric according to claim 9 wherein said spots are arranged so that said spaces between said spots are not in continuous alignment in any direction along the lateral extent of the fabric.

11. As an article of manufacture, a flexible fabric of unspun long cotton fibers disposed in the form of a sheet, said fibers being spot bonded at a multiplicity of essentially independent adjacent spaced spots to impart to said sheet tensile strength in all directions, said spots occupying a major proportion of the lateral extent of said sheet, being individually of the order of 0.01 to 0.06 square inch in area and being spaced apart at all points of the periphery thereof by a distance of the order of 0.01 to 0.06 inch, the fibers of said sheet in the spaces between said spots being capable of flexure and affording over-all flexibility of said sheet and said spots being regularly arranged with the location of the successive spots preventing continuous alignment of said spaces in any direction along the lateral extent of the fabric.

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