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2,913,365

FIBROUS WEBS AND METHOD AND APPARATUS FOR MAKING SAME

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2 Sheets-Sheet 1

FIG. 1

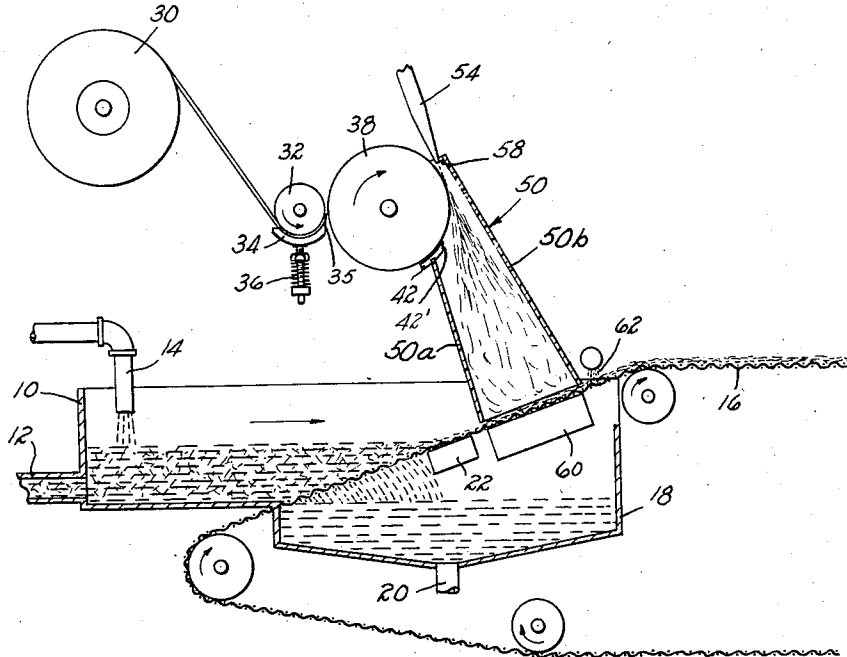
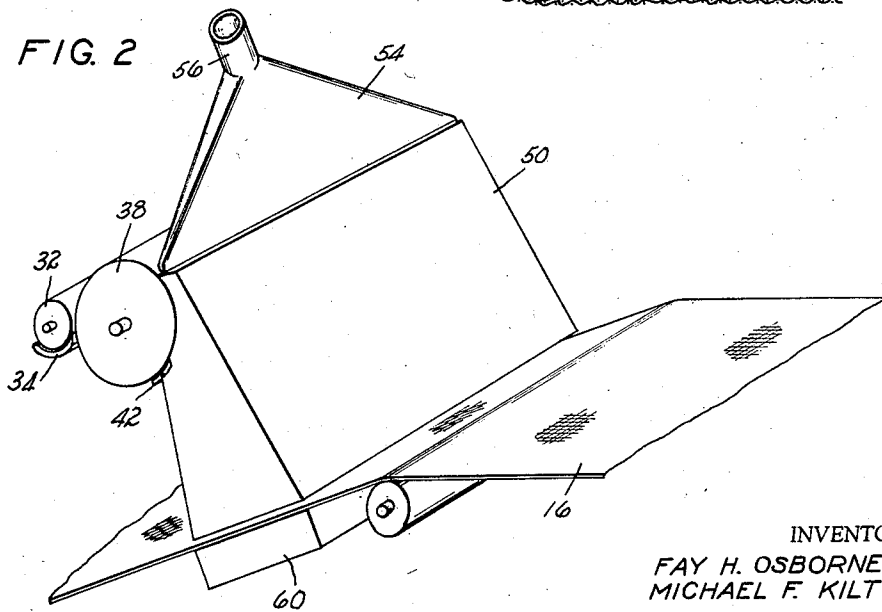


FIG. 2



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2 Sheets-Sheet 2

FIG. 3

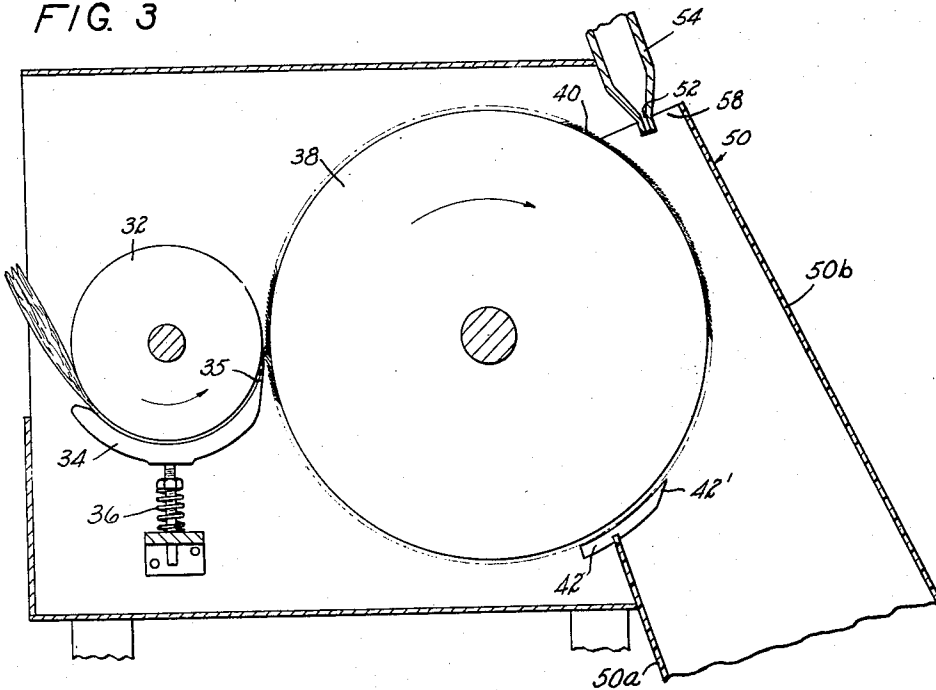


FIG. 4

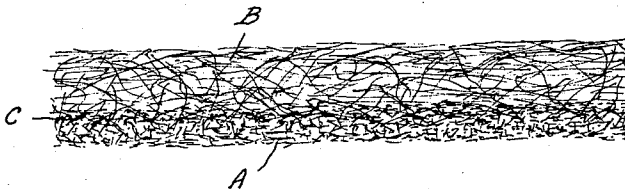


FIG. 5

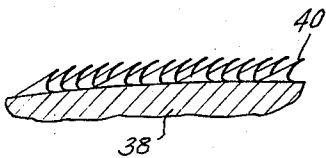
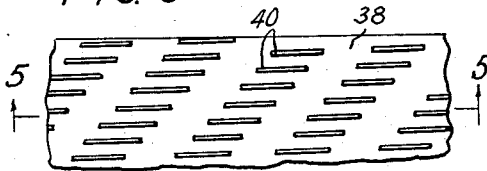


FIG. 6



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**FIBROUS WEBS AND METHOD AND APPARATUS FOR MAKING SAME**

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Application December 1, 1954, Serial No. 472,496

23 Claims. (Cl. 162—201)

The present invention relates generally to a new method of making non-woven fibrous webs and to the novel non-woven fibrous webs so produced. The invention relates more particularly to a novel method of forming non-woven fibrous webs utilizing paper-making machinery in combination with means for incorporating into the web, fibers of textile length. The resultant product of the present invention is a strong, flexible, soft, uniform, porous, non-woven web containing both fibers of paper-making length and fibers of textile length and having unique properties and characteristics rendering the product suitable for many and diversified uses.

Heretofore, fibers of textile length have been utilized mainly in conventional textile processes wherein the fibers are spun into yarn and thread and then woven into fabrics. In an attempt to eliminate the spinning and weaving operation, so-called "non-woven fabrics" have been developed which are made by forming a mat of textile fibers and thereafter binding the fibers together such as by coalescing the fibers or by means of various bonding agents. The textile fiber mats from which most non-woven fabrics are made are usually formed on carding machines which mechanically produce webs in which most of the fibers are laid out or oriented in the direction in which the web is produced with the result that after bonding, the web has only a very slight transverse tensile strength which can be corrected only to some extent by making a relatively thick multi-ply fabric of two or more webs laid transversely to each other, an expedient which has been found to be impractical and expensive. The webs formed on carding machines are relatively heavy and non-uniform since carded webs of less than about one-half ounce per square yard are impractical and the distribution of fibers in the web is so uneven as to cause the weight variations in different areas of as much as fifty to seventy-five percent. In addition, carding machines are relatively slow in operation and usually are incapable of producing webs exceeding about forty inches in width.

Attempts have been made heretofore to form webs of textile fibers by means other than carding machines such as by air flotation, screen depositions and the like, but these methods also are characterized by a low production rate, narrow widths and high cost and the webs produced in this manner are usually relatively thick and uneven in fiber distribution and appearance. As in the case of webs formed on carding machines, the web must be treated subsequently to bond the fibers together. So far as can be determined, these various expedients and substitutes for carding machines have met with little commercial success.

It has long been the practice, of course, to form fibrous webs which may be classified as paper rather than non-woven fabrics by paper-making methods. In conventional paper-making processes, the fibers are dispersed in an aqueous carrier which is permitted to flow through a traveling screen or Fourdrinier wire with the consequent deposition of the fibers on the wire in the form

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of a paper web. Paper-making processes and apparatus have been highly developed to the extent that webs having a wide range of weights and of very good uniform quality may be prepared at high speeds and in widths of the order of one hundred inches or more. However, since paper-making techniques require the use of an aqueous dispersion of the fibers, it is necessary to use water dispersible fibers which are fibers of relatively short length. The fibers generally utilized range from practically negligible lengths up to lengths of the order of three-eighths inch. In most cases, the fibers are natural fibers which usually are hydrated and which have the property of bonding together to form a strong web. In most instances, paper products are relatively dense, and stiff and lack the porosity, hand and textile appearance of non-woven fabrics. It is possible, however, by the use of special techniques as disclosed, for example, in the coinventor Osborne's prior Patents Nos. 2,045,095, -6 and 2,626,214 to form porous, relatively long fibered, non-hydrated paper, but even then the fibers used are necessarily shorter and less absorbent than textile fibers.

In accordance with the present invention, the disadvantages of prior web forming methods are overcome and there is produced a new kind of web having superior physical characteristics formed with a diversified fiber content not heretofore possible. In accordance with the invention, the web is produced on a paper machine by forming an aqueous dispersion of paper-making fibers into a base and while this base is newly formed on the wire screen and in a porous condition, but while it is still moist, depositing therein by means of an air blast a uniform dispersion of fibers of textile length, this being accomplished in such manner that the textile fibers are securely and uniformly bonded to the fibers of the base layer to form a coherent web. The resulting web contains both fibers of paper-making length and fibers of textile length and is considerably stronger and more uniform than non-woven fabrics as heretofore formed while having a high degree of softness, absorbency, flexibility, porosity, hand, and other characteristics normally associated with textile materials.

Inasmuch as the method of the present invention will produce cloth-like webs which are very soft, flexible, long fibered and porous, strong and absorbent and can be made in very thin or heavy webs and may contain two or more fibers of widely diversified characteristics, the product has a practically unlimited use as a substitute for paper and/or cloth. For example, in the medical field, it may be used for bandages, pads, caps, gowns, respirators, sheets and filtering. In the industrial field, it is suitable for all kinds of filtering such as filters for milk, oil, beer, chemicals, air and foods. In the bag industry, it is suitable for desiccant bags, soap bags, beverage bags, rayon cake covers, dyeing bags and general infusion bags. For household purposes, it may be used as a cleaner for general purposes such as wiping, polishing and as a chamois cloth substitute, for filtering fats, waxes and foods, as a material for table napkins, doilies, window drapes, table covers, diapers and as a packaging material. It also is suitable for use commercially in the wrapping of soft metal goods and gift packages and for such miscellaneous uses as aids for hair waving, electrical condensers, manufacturing pressure sensitive tapes, meat casings, mimeo type stencils and in clothing manufacture. Other uses for which the product may be used will be apparent.

In order that the invention may be better understood, reference may be had to the accompanying drawings in which:

Figure 1 is a diagrammatic side view of an exemplary machine which may be utilized to carry out the invention; Figure 2 is a perspective view of the portion of the

machine for incorporating textile fibers into the web;

Figure 3 is an enlarged longitudinal cross-sectional view of the portion of the machine shown in Figure 2;

Figure 4 is a diagrammatic cross-sectional view of a typical web which may be formed in accordance with the invention;

Figure 5 is an enlarged cross-sectional view of a portion of the periphery of the spreader roll of the machine taken along the line 5—5 of Figure 6; and

Figure 6 is a fragmentary enlarged top view of the spreader roll.

Referring to the drawings, and particularly Figure 1 thereof, it will be observed that the paper-making machine illustrated is similar to that shown in co-inventor Osborne's prior United States Patents Nos. 2,045,095 and 2,414,833. The apparatus consists of a head box 10 into which is fed a slurry of fibers through the inlet 12. Additions of fresh water can be made through the pipe 14 as required. The fibers used to form the slurry in the head box 10 can be any of the natural fibers as used in the usual paper-making processes such as wood, jute, cotton and sisal, either in their full fiber length or refined and hydrated to shorter lengths to give increased strength. They can also be of longer length and may include synthetic fibers as described in the co-inventor Osborne's United States Patents Nos. 2,045,095 and 2,414,833 in which longer fiber lengths are used as compared to usual paper-making practices, such as Musa textiles, carao, sisal, Indian hemp, phormium tenax, viscose and acetate rayon. While the selection of a particular furnish is subject to wide variation within the skill of one versed in the art of paper manufacture, we have found that in the event that the textile fibers to be later added to the web are composed of synthetic or regenerated fibers having very little binding power, of themselves, it is preferred to select fibers for use in the slurry which will have a high binding strength or to add chemical binders to the slurry. These chemical binders can be starches, urea formaldehyde resins, polyvinyl acetates, polyvinyl chloride, rosin, rubber latex, glue, sodium carboxymethylcellulose, and combinations of these binders.

The slurry in the head box travels in the direction of the arrow until it comes into contact with a continuously moving wire screen or Fourdrinier wire 16 which forms the right-hand end of the head box as viewed in Figure 1. The water from the slurry drains through the wire screen into the save-all 18 from which it may be withdrawn through the pipe 20 for re-use. As the water drains through the wire screen, the fibers of course are deposited on the wire screen in a uniform manner to form a web. A suction box 22 helps to free the newly formed web of excess water. At this point the web is in a very wet condition and consists approximately of ninety-two percent water and eight percent fiber. In general, it is important to use a fiber slurry of the type which will form a porous web on the wire. Such a web is sometimes referred to in the art as having a "free" fiber structure and is characterized by its ability to lose water rapidly. As a result, the water normally filling the interstices of the web as it forms on the wire quickly drains through the wire leaving a web structure which is highly porous to air.

The thickness of the web formed on the paper-making part of the apparatus will depend, of course, on the composition or dilution of the slurry in the head box and the rate at which the Fourdrinier wire is traveling. It is an advantage of the present invention that a very thin initial web will suffice to form the final composite web having good strength characteristics.

Turning now to the apparatus for incorporating textile fibers into the web, the source of the fibers, as illustrated in the drawings, preferably is a lap roll 30, which is a readily available commercial form of staple fibers arranged so that the fibers are aligned or oriented in the feed direction. A lap roll is formed by running staple

fibers through a carding machine which orients the fibers in a machine direction and lays them parallel so that they may be taken off the carding machine in the form of a sliver, which is a very loose ropelike mat. It is preferred to utilize fibers which are available in a highly oriented form known as "drawn slivers." To form a lap roll, a plurality of slivers are run on a textile machine called a "lap winder" which butts the slivers together and somewhat compresses them so that they can be unwound in a loose lap. While a lap roll is probably the most convenient source of fibers in oriented form for feeding into the machine, it will be appreciated that a plurality of individual slivers or other forms of oriented staple fibers may be used.

The fibers used in forming the lap roll 30 or other source of oriented fibers can be any textile fibers whether synthetic, regenerated or natural fibers, virgin or reclaimed. By "textile fibers" we mean a staple fiber having a fiber length of from one-half inch to four inches, such as can be run on a carding machine to form a sliver. Among the synthetic fibers which may be utilized are cellulose esters of acetate and viscose rayon; methyl, ethyl and benzol cellulose; vinyl compounds such as vinyl chlorides; vinyl acetates and the copolymers of the same; polymers of the styrenes; polyamides such as nylon; and the proteinaceous fibers such as those formed from casein and soybean. Among the natural fibers which may be used are long staple natural fibers such as cotton, flax, jute, hemp and ramie.

The lap from the lap roll 30 is fed by means of a feed roll 32 which may be serrated if desired and which has associated therewith a shoe 34. The shoe 34 is biased toward the feed roll 32 by means of an adjustable spring 36. The adjustment of the spring 36 is such that the lap will be firmly held between the feed roll 32 and shoe 34 to insure proper action of the spreader roll 38, to be described hereafter, while at the same time permitting the fibers to be carried or fed through continuously without adverse effect on the lap.

The spreader roll 38 is a drum whose surface is formed with a plurality of sawlike teeth 40 inclined in the direction of rotation of the drum. In accordance with the invention, the spreader roll 38 is mounted for rotation at high speeds of the order of 500 r.p.m. or more with its periphery closely adjacent the delivery end of the feed roll 32 and shoe 34. The shoe 34 has a carefully machined beveled nose portion 35 which is set to provide a very small clearance of the order of a few hundredths of an inch between it and the spreader roll 38. In the preferred operation of the machine, the feed roll 32 is rotated at a relatively low speed of the order of 3 to 10 r.p.m. while the spreader roll, which is considerably larger in diameter, is rotated at speeds of 500 r.p.m. or more. The effect of the apparatus as thus far described is that the lap will be carried around between the feed roll 32 and the shoe 34 so that the fibers thereof will come in contact with the rapidly moving teeth 40 of the spreader roll 38. The lap, however, is securely held between the feed roll 32 and shoe 34 to within a very short distance from the spreader roll teeth so that the fibers of the lap are teased out substantially individually by the spreader roll 38 and removal of the fibers in clumps or bunches is substantially avoided. The result is that, as the spreader roll 38 is rotated, the teeth will pick up and thus separate the individual staple fibers from the feed roll. The rate of feed of fibers to the spreader roll 38 is controlled, of course, by regulating the speed of rotation of the feed roll 32.

The right-hand peripheral portion of the spreader roll 38, as viewed in Figure 3, is received within an open-ended housing 50 which, as shown in Figures 2 and 3, is trapezoidal in transverse cross section and rectangular in longitudinal cross section, thus forming a downwardly and outwardly flaring passageway from the forward edge or periphery of the spreader roll 38. The upper end of

the rear wall 50a of housing 50 is made to fit a doctor blade as shown at 42. This blade extends across the full width of the spreader roll 38 and is set to within .05 inch of roll 38. The nose of this blade, as indicated at 42', is beveled at a sharp angle. The object of this blade is to keep the fibers which have been blown off the roll 38 from following around the roll. The blade tends to lead them off into housing 50. The bottom of the housing 50 is open and disposed at a very small distance above the screen 16, sufficient to clear the paper web formed thereon and preferably immediately following the suction box 22.

A high-speed laminar jet of air is introduced at the top of the housing closely adjacent and tangential to the periphery of the spreader roll 38 through a slot-type orifice 52 located along the bottom of a triangular-shaped manifold 54 which is connected at 56 to a source of high pressure air (not shown in the drawings). The orifice 52 is directed tangentially of the spreader roll 38 and preferably is located approximately four inches from the point of tangency with the spreader roll. The housing 50 is constructed so that the distance between the orifice 52 and the front wall 50b as indicated at 58 is approximately two inches, which has been found to be the optimum for avoiding turbulence. The air introduced into the manifold 54 is controlled so that a thin laminar flow of air is created tangential to the spreader roll, which has a very much greater velocity than the peripheral speed of the spreader roll so that the individual fibers carried by the teeth of the spreader roll are dislodged and carried off by the air stream. By such control of the air feed, the laminar air jet can be regulated to effect complete fiber removal from the spreader roll 38 without flocculation and the fibers travel downwardly toward the screen within the passageway provided by the housing 50 in highly dispersed form.

It is extremely important to transfer the individual fibers from the teeth of the spreader roll 38 to the web on the screen 16 without flocculation or bunching of the fibers during the process. In keeping with this aim, the surface of the roll should be entirely cleaned by the air blast so that the fibers will not be carried around by the spreader roll and thus given a chance to build up in bunches or clumps. Also, the presence of moisture is to be avoided since any wetting of the fibers will cause them to bunch up instead of dispersing individually. By way of specific example, we have found that an air blast of sufficient force to completely clean the spreader roll of fibers even at high productions, exceeding 200 pounds per hour on an 80" width, can be obtained with a relatively small volume of 375 cubic feet per minute on this same width (approximately 50 cubic feet per minute for each foot of roll width) by using a nozzle or jet with an orifice slit approximately .005" and a static pressure of 90 pounds per square inch. Under these conditions whereby the air is allowed to expand freely from 90 pounds per square inch and exert its full dynamic force tangentially against the spreader roll, which distance of expansion from the orifice to the spreader surface is 4 inches, a tremendous confined force is brought to bear against the fiber-covered surface of the roll. Large slit sizes of the orifice may be used but this only serves to increase the volume of air used without gaining additional force because of no velocity gain. Also it is desirable to keep the volume at a minimum to avoid difficulty in air removal through the wire. An idea of the magnitude of this air blast as specified above may be gained from the velocity in the orifice which is 120,000 feet per minute. The peripheral speed of the spreader roll 38 is in the range of 1800 to 7200 feet per minute, depending on production desired. From this it will be observed that the velocity of the air blast is from 16 to 66 times faster (although in the same direction) than the velocity of the spreader roll. This is believed to be the principal reason why the fibers are blown free from

the spreader roll and randomly distributed into the housing 50. We also have found that, in order to avoid turbulence of the air flow between the spreader roll and the web, which normally would induce undesirable flocculation of the fibers, it is preferable to mount the spreader roll 38 as close as practical to the wire 16 so that the length of housing 50 may be kept to a minimum. It also is important to so dimension the housing 50 that its interior approximates the form of the laminar air flow, thereby avoiding the inducing of side currents, particularly upwardly from the bottom of the housing which would cause turbulence and hence flocculation of the fibers.

Beneath the wire 16 and opposite to the outlet opening of the housing 50 is a suction box 60 which is co-extensive with the opening of the housing 50 and which is connected to a suction pump (not shown) having sufficient capacity to handle the volume of air carried downwardly through the housing 50. The result is that the air is sucked through the screen 16 and the newly formed wet but porous paper web thereon, while the fibers carried by the air are separated out by the web in a highly dispersed and uniform but non-oriented manner. By providing ample suction at the suction box 60, substantially all of the air can be drawn downwardly through the web thereby avoiding turbulence and air flow outwardly along the surface of the web which might cause disintegration or non-uniformity of the web, and substantially all of the textile fibers are deposited and drawn into the web without escaping outwardly from the machine to atmosphere. The regulating of the air flow and suction, as well as speed of the machine, can be such as to entirely avoid orientation of the textile fibers or to create some orientation if desired.

The textile fibers thus deposited in and on the porous moving paper web while it is still very wet and fluid are found to be interlocked or intermeshed with the paper web so as to form a strong bond therewith. If desired, a water spray 62 may be applied to the web immediately following the deposition of the textile fibers so as to assist in laying down the dry fiber portion of the web and causing it to unite with the wet paper web. The combined web, which now consists of both paper-making fibers and textile fibers, is continuously carried forwardly by the wire 16 and may subsequently be handled in accordance with usual paper-making procedures, such as shown in the co-inventor's prior Patents Nos. 2,045,095 and 2,414,833, the web being couched from the wire and dried in accordance with conventional paper-making techniques.

The resulting web product has many of the characteristics of a paper product insofar as strength, uniformity, etc. are concerned, while at the same time it has many of the properties of a textile material, including softness, porosity and hand. Figure 4 illustrates, in general, the physical form of the product, which includes the paper web portion A, the textile fiber portion B, and an intermediate zone C where there is an interlocking of the two fibers. The product is characterized by the base A, which is predominantly formed of paper-making fibers; the intermediate zone C, which gradually varies from predominantly paper-making fibers to textile fibers; and the upper zone B, which is predominantly textile fibers.

As will be realized, webs of very different and special characteristics may be obtained by proper selection of the various fibers. For example, the lap roll may include thermoplastic fibers to give heat sealing properties or may comprise fibers with a high degree of shrinkage or a high degree of stretch. If desired, the fibers may consist of some which are soluble in certain solvents and insoluble in others. Due to the fact that there is a combination of a very wet paper web, in its forming stages and prior to any pressing or drying, with a textile web also in the process of being formed, it is possible to obtain practically unlimited combinations of webs. For example, it may be desired to form a final web having entirely oppo-

site characteristics on its two sides. For example, one side may be composed of very short, highly hydrated fibers forming a thin filmlike paper web, while the other side is composed of long, soft textile-length fibers entirely dissimilar in physical characteristics. As a further specific example of variations of the final web, one side may be made highly impervious to liquids while the other side is made very absorbent, thus providing a product which is ideal for diapers or catamenial pads. Grain ratio, porosity, flexibility and strength may be controlled to a degree not possible heretofore. The webs and the components of the webs may be made as thick or thin as desired within the range of the method. In general, the maximum thickness which can be obtained in the final web will be about one-eighth inch. The usual range of operation generally will be to form a final web product having a thickness of .001 to .02".

In order that the invention may be fully understood, the following is given by way of illustration, but not by way of limitation, of specific examples of the practice of the invention:

#### Example 1

In this example, the fibers used in the slurry were hemp fibers and wood fibers in the proportion of 20 pounds of hemp fibers having an average length of  $\frac{3}{16}$ " and 50 pounds (dry weight) of so-called short wood fibers which were highly hydrated and of very short length. This mixture was first made up into an initial dispersion in water by use of a beater and then was further diluted with water to produce a slurry in the head box having a fiber concentration of approximately .002%. The paper machine was operated at a speed such that the Fourdrinier wire traveled at 75 feet per minute. The textile fibers used were in the form of a lap roll made of 50-grain slivers of viscose rayon staple fiber having an average length of  $1\frac{1}{16}$ " and a denier of 1.5. The feed roll was operated at a speed of 3 r.p.m. while the spreader roll was operated at a speed of 600 r.p.m. The air blast was provided through a nozzle orifice of .005" at a pressure of 90 pounds per square inch. Sufficient suction was applied at the suction box 60 to draw substantially all of the air from the air blast through the web. The sheet produced in this manner was an 8-pound sheet consisting of approximately 85 percent rayon fibers and 15 percent hempwood, the total thickness of the web being approximately .002". The resultant web after drying had good strength, softness, porosity, and absorbency.

#### Example 2

In this example, a dilute slurry of hemp fibers and wood fibers was introduced into the head box and the machine was operated substantially the same as in Example 1. The textile fibers were changed to a lap roll composed of 10 percent 3-denier nylon and 90 percent 5-denier viscose rayon, both having an average staple length of  $1\frac{1}{16}$  inches. The resulting web, having approximately the same weight and proportion of textile fibers as in the web of Example 1, was less absorbent and more stable to moisture, rendering the web particularly suitable for use in wearing apparel.

#### Example 3

In this example, the furnish to the head box and the operation of the machine again were approximately the same as in Example 1, but the lap roll was changed to 100 percent raw cotton middling having an average fiber length of 1 inch. The resulting web was found to have improved flexibility and good drape characteristics as well as increased absorbency, rendering it particularly suitable for such uses as hospital pads.

#### Example 4

In this example, there was added to the slurry of Example 1 approximately 10 percent polyvinyl acetate as a binder and a lap roll of micro filament glass fibers of  $\frac{1}{2}$  to  $1\frac{1}{2}$  micron in diameter was substituted. The resulting web, having a dull white appearance, was characterized by good electrical resistance, rendering it particularly suitable as an insulation for use in electrical equipment.

#### Example 5

In this example, a slurry was introduced to the head box which was formed of 100 percent rayon fibers cut to  $\frac{3}{8}$ -inch length, to which was added approximately 10 percent carboxymethylcellulose as a binder. The lap roll for providing the textile fibers was formed of vinyon fibers (a copolymer of polyvinyl acetate and polyvinyl chloride) of average staple length. The resulting web, due to the presence of thermoplastic vinyl fibers, was heat sealable, rendering it particularly suitable for use in infusers such as tea bags.

#### Example 6

In this example, a heat sealable web was produced by utilizing a slurry in the head box of the paper machine having a fiber content of 20 percent very short wood fiber and 80 percent vinyon fiber (copolymer of polyvinyl acetate and polyvinyl chloride) cut to short lengths and on the textile part a lap roll of 100 percent viscose rayon staple  $1\frac{1}{16}$  inches long and  $1\frac{1}{2}$  denier weight. In this example, the thermoplastic fibers were in the bottom section of the web (the reverse of Example 5) and the length thereof was very much shorter than the length of the thermoplastic fiber of the preceding example. This provided good heat sealing properties and permitted the forming of heat seal bags with the textile length fibers on the exterior surface of the bag.

From the preceding description and specific examples, it will be appreciated that in carrying out the invention many combinations of fibers may be employed to produce webs of a wide range of characteristics, and all such variations which will be apparent to one skilled in the art are intended to be included within the scope of the invention.

We claim:

1. A method of forming a soft, porous, non-woven web containing textile fibers having a fiber length in the range of one-half to four inches and paper-making fibers having a fiber length not exceeding three-eighths inch comprising depositing the paper-making fibers on a wire screen from a dilute aqueous dispersion thereof to form a porous wet web of said fibers, and while said web is on the screen in the form of a porous wet web passing therethrough an air blast containing the textile fibers individually dispersed therein to cause the textile fibers to deposit in the web.

2. A method of forming a soft, porous, non-woven web containing textile fibers having a fiber length in the range of one-half to four inches and paper-making fibers having a fiber length not exceeding three-eighths inch comprising forming a dilute aqueous dispersion of the paper-making fibers, continuously forming a porous web from said dispersion on a moving wire screen, dispersing the textile fibers in an air blast directed toward the traveling wire screen and porous web formed thereon, and applying suction to the underside of the screen sufficient to draw substantially all of the air blast through the web and screen.

3. A method of forming a porous non-woven web containing textile fibers having a fiber length in the range of one-half to four inches and paper-making fibers having a fiber length not exceeding three-eighths inch comprising forming a dilute slurry of the paper-making fibers, flowing the slurry onto a traveling wire screen to continuously form a wet paper web, forming an air blast containing the

textile fibers highly dispersed therein, and, while said web is on the screen and in moist condition, passing the air blast therethrough while applying suction to the underside of the screen, the textile fibers being removed from the air blast by the web and being embedded in the web.

4. A method of forming a soft, porous non-woven web containing textile fibers having a fiber length in the range of one-half to four inches and paper-making fibers having a fiber length not exceeding three-eighths inch comprising forming a dilute aqueous dispersion of the paper-making fibers, continuously forming a porous web from said dispersion on a moving wire screen, dispersing the textile fibers in a laminar non-turbulent air blast directed toward the traveling wire screen and porous wet web formed thereon and applying suction to the underside of the screen sufficient to draw substantially all of the air blast through the web and screen.

5. A method for forming a soft, porous non-woven web containing textile fibers having a fiber length in the range of one-half to four inches and paper-making fibers having a fiber length not exceeding three-eighths inch comprising forming a dilute aqueous dispersion of the paper-making fibers, continuously forming a porous web from said dispersion on a moving wire screen, introducing the textile fibers in individual separated form into an enclosed laminar non-turbulent air blast of high velocity directed toward the traveling wire screen and wet porous web formed thereon and applying suction to the underside of the screen sufficient to draw substantially all of the air blast through the web and screen.

6. A method of forming a soft, porous non-woven web containing textile fibers having a fiber length in the range of one-half to four inches and paper-making fibers having a fiber length not exceeding three-eighths inch comprising forming a dilute aqueous dispersion of the paper-making fibers, continuously forming a porous web from said dispersion on a moving wire screen, disposing the textile fibers individually on the teeth of a rotating toothed roll, removing the fibers from the teeth of the roll and depositing them in said porous web by means of an air blast directed tangentially of the roll toward the traveling wire screen and porous web formed thereon, and applying suction to the underside of the screen sufficient to draw substantially all of the air blast through the web and screen.

7. A method of forming a soft, porous non-woven web containing textile fibers having a fiber length in the range of one-half to four inches and paper-making fibers having a fiber length not exceeding three-eighths inch comprising forming a dilute aqueous dispersion of the paper-making fibers, continuously forming a porous web from said dispersion on a moving wire screen, disposing the textile fibers individually on the teeth of a rotating toothed roll, removing the fibers from the teeth of the roll and depositing them in said porous web by directing a laminar non-turbulent air blast having a velocity greater than the peripheral speed of the roll tangentially of the roll toward the traveling wire screen and porous web formed thereon and applying suction to the underside of the screen sufficient to draw substantially all of the air blast through the web and screen.

8. A method of forming a soft, porous non-woven web containing textile fibers having a fiber length in the range of one-half to four inches and paper-making fibers having a fiber length not exceeding three-eighths inch comprising forming a dilute aqueous dispersion of the paper-making fibers, continuously forming a porous web from said dispersion on a moving wire screen, supplying the textile fibers in oriented form for pickup individually by the teeth of a rapidly rotating spreader roll, removing the fibers from the teeth of the roll and depositing them in said porous web by directing a laminar non-turbulent air blast having a velocity very much greater than the peripheral speed of the roll tangentially of the roll toward the traveling wire screen and porous web formed thereon and

applying suction to the underside of the screen sufficient to draw substantially all of the air blast through the web and screen.

9. A method of forming a soft, porous non-woven web containing textile fibers having a fiber length in the range of one-half to four inches and paper-making fibers having a fiber length not exceeding three-eighths inch comprising forming a dilute aqueous dispersion of the paper-making fibers, continuously forming a porous wet web from said dispersion on a traveling wire screen, applying the textile fibers in oriented form to a rapidly rotating roll having teeth for separating out the individual fibers, removing the fibers from the teeth of the roll by means of a laminar non-turbulent air blast directed toward the traveling wire screen and porous web formed thereon, said air blast being directed tangentially to the roll and moving in the direction of rotation of the roll at a rate greatly exceeding the peripheral speed of the roll, simultaneously applying suction to the underside of the screen over an area substantially coextensive with the air blast and sufficient to draw substantially all of the air blast through the web and screen, and thereafter drying the web.

10. A method of forming a soft, porous non-woven web containing textile fibers having a fiber length in the range of one-half to four inches and paper-making fibers having a fiber length not exceeding three-eighths inch comprising forming a dilute aqueous dispersion of the paper-making fibers, continuously forming a porous web from said dispersion on a moving wire screen, feeding textile fibers in the form of a lap roll for engagement by the teeth of a rapidly rotating toothed roll, removing the fibers from the teeth of the roll and depositing them in said porous web by directing a laminar non-turbulent air blast having a velocity very much greater than the peripheral speed of the roll tangentially of the roll and in the direction of rotation of the roll toward the traveling wire screen and porous web formed thereon and applying suction to the underside of the screen sufficient to draw substantially all of the air blast through the web and screen.

11. Apparatus for forming a soft, porous non-woven web containing textile fibers and paper-making fibers comprising a traveling wire screen, means for flowing a dilute dispersion of paper-making fibers onto the screen to form a wet porous web thereon, means for directing a laminar non-turbulent air blast downwardly toward the screen and wet porous web thereon, a housing enclosing said air blast, means for supplying individual textile fibers to said air blast, and means for applying suction to the underside of the screen over an area substantially coextensive with the bottom of the housing.

12. Apparatus for forming a soft, porous non-woven web containing textile fibers and paper-making fibers comprising a traveling wire screen, means for flowing a dilute dispersion of paper-making fibers onto the screen to form a wet porous web thereon, a rotatable spreader roll mounted for rotation above the screen, means for feeding textile fibers for individual pickup by the spreader roll, said spreader roll having teeth on its periphery for engaging the individual fibers, means for directing a laminar non-turbulent air blast downwardly toward the screen tangentially of the spreader roll, a housing between the spreader roll and screen for enclosing said air blast, and means for applying suction to the underside of the screen over an area substantially coextensive with the bottom of the housing.

13. Apparatus for forming a soft, porous, non-woven web containing textile fibers and paper-making fibers comprising a traveling wire screen, a head box for flowing a dilute dispersion of paper-making fibers onto the screen, means for drawing off liquid from the underside of the screen, a rotatable toothed roll mounted for rotation above the screen, means for feeding textile fibers in oriented form to the toothed roll, means for directing a laminar

air blast downwardly toward the screen substantially perpendicular to the screen and tangentially of the spreader roll and in the direction of rotation of the roll, a housing between the spreader roll and screen enclosing said air blast, and means for applying suction to the underside of the screen over an area substantially coextensive with the bottom of the housing.

14. In an apparatus for forming a soft, porous, non-woven web containing textile fibers and paper-making fibers on paper-making machinery of the type having a traveling wire screen, means for introducing textile fibers into a web formed on said screen comprising a rotatable spreader roll mounted for rotation above the screen, means for feeding textile fibers in oriented form to the spreader roll, said spreader roll having teeth on its periphery for engaging individual textile fibers, a narrow slot-type nozzle for directing a laminar air blast downwardly toward the screen tangentially of the spreader roll, a housing between the spreader roll and screen for enclosing said air blast, and means for applying suction to the underside of the screen over an area substantially coextensive with the bottom of the housing.

15. Apparatus for forming a soft, porous, non-woven web containing textile fibers and paper-making fibers comprising a traveling wire screen, a head box for flowing a dilute dispersion of paper-making fibers onto the screen, means for drawing off liquid from the underside of the screen, a rotatable spreader roll mounted for rotation above the screen, means for feeding textile fibers in oriented form to the spreader roll, said spreader roll having teeth on its periphery for engaging individual textile fibers, a narrow slot-type nozzle for directing a laminar air blast downwardly toward the screen tangentially of the spreader roll, a housing between the spreader roll and screen enclosing said air blast, and means for applying suction to the underside of the screen over an area substantially coextensive with the bottom of the housing.

16. Apparatus for forming a soft, porous non-woven web containing textile fibers and paper-making fibers comprising a traveling wire screen, a head box for flowing a dilute dispersion of paper-making fibers onto the screen, means for drawing off liquid from the underside of the screen, a rotatable spreader roll mounted for rotation above the screen, means for feeding the textile fibers in oriented form to the spreader roll comprising a feed roll and an arcuate shoe biased toward the feed roll having one edge disposed closely adjacent the periphery of the spreader roll, said spreader roll having teeth on its periphery for withdrawing individual fibers from between the feed roll and shoe, a narrow slot-type nozzle for directing a laminar air blast downwardly toward the screen tangentially of the spreader roll, a housing between the spreader roll and screen for enclosing said air blast, and means for applying suction to the underside of the screen over an area substantially coextensive with the bottom of the housing.

17. Apparatus for forming a soft, porous non-woven web containing textile fibers and paper-making fibers comprising a traveling wire screen, a head box for flowing a dilute dispersion of paper-making fibers onto the screen, means for drawing off liquid from the underside of the screen, a rotatable spreader roll mounted for rotation above the screen, means for rotating the spreader roll at high speed, means for feeding textile fibers to the spreader roll comprising a supply roll of textile fibers in oriented form, a feed roll and an arcuate shoe biased toward the underside of the feed roll for receiving the fibers from the supply roll, said shoe having one edge disposed closely adjacent the periphery of the spreader roll, said spreader roll having teeth on its periphery for withdrawing individual fibers upwardly from between the feed roll and shoe, a narrow, slot-type nozzle for directing a laminar air blast downwardly toward the screen tangentially of the spreader roll and in the direction of

rotation of the roll, a housing between the spreader roll and screen for enclosing said air blast and of approximately the same cross-sectional dimensions as the air blast, and means for applying suction to the underside of the screen over an area substantially coextensive with the bottom of the housing.

18. Apparatus for forming a soft, porous, non-woven web containing textile fibers and paper-making fibers comprising a paper-making machine having a head box and a continuously movable inclined wire screen forming one end of the head box, a housing extending upwardly from the wire screen adjacent the head box forming an air blast passageway of rectangular cross section, a suction box disposed underneath the screen below the housing, a spreader roll having a portion of its periphery received in the upper end of the housing and mounted for rotation so that the portion of the periphery in the housing is rotating in a downwardly direction, and means forming a slot type orifice in the upper end of the housing closely adjacent and tangential to the periphery of the spreader roll in the housing.

19. An apparatus for producing a non-woven web from a lap containing textile fibers having a fiber length in the range of one-half to four inches and an aqueous slurry of paper-making fibers having a fiber length not exceeding three-eighths inch comprising a traveling wire screen, a head box for flowing a dispersion of the paper-making fibers onto the screen, means for drawing off liquid from the underside of the screen, a rotatable spreader roll mounted above the screen, means for feeding the lap to the periphery of the spreader roll to permit extraction of individual textile fibers from the lap by the teeth of the spreader roll, a downwardly extending housing enclosing a portion of the periphery of the roll and forming a laminar air passageway between the roll and the screen, an elongated nozzle extending across the top of the housing for providing a laminar blast of air downwardly through the housing, and a suction box underneath the screen having a suction area as large as the lower end of the housing.

20. A soft, flexible, porous web of good strength and of uniform and even weight, texture and thickness throughout comprising a porous web formed of uniformly dispersed paper-making fibers having a fiber length not exceeding three-eighths inch and uniformly dispersed textile fibers having a fiber length of one-half to four inches extending into and partially intermingled with the paper-making fibers so as to be interlocked and supported thereby.

21. A soft, flexible, porous web of good strength and of uniform and even weight, texture and thickness throughout comprising a base sheet of water-laid paper-making fibers having a fiber length not exceeding three-eighths inch, said base sheet being merged into and interlocked with an upper layer of uniformly dispersed air-laid textile fibers having a fiber length in the range of one-half to four inches.

22. A soft, flexible, porous web of good strength and of uniform and even weight, texture and thickness throughout comprising a water-laid base of paper-making fibers having a fiber length not exceeding three-eighths inch interlocked with and supporting a layer of uniformly dispersed air deposited textile fibers having a fiber length in the range of one-half to four inches, said textile fibers being partially drawn into the water-laid base to form a continuous web varying from predominantly paper-making fibers on one side to predominantly textile fibers on the other side.

23. A soft, flexible, porous web of good strength and of uniform and even weight, texture and thickness throughout comprising a mixture of two types of fibers in interlocked relationship, the fibers of one type being water-laid paper-making fibers having a fiber length not exceeding three-eighths inch, and the fibers of the other type being air-laid textile fibers having a fiber length



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of one-half to four inches, said fibers being interlocked while the paper-making fibers are in the form of a porous wet web by passing an air blast containing dispersed textile fibers therethrough.

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