

Aug. 15, 1967

A. H. BASSETT ETAL
NON-WOVEN COTTON WEB

3,336,182

Original Filed Dec. 18, 1961

4 Sheets-Sheet 1

Fig. 1.

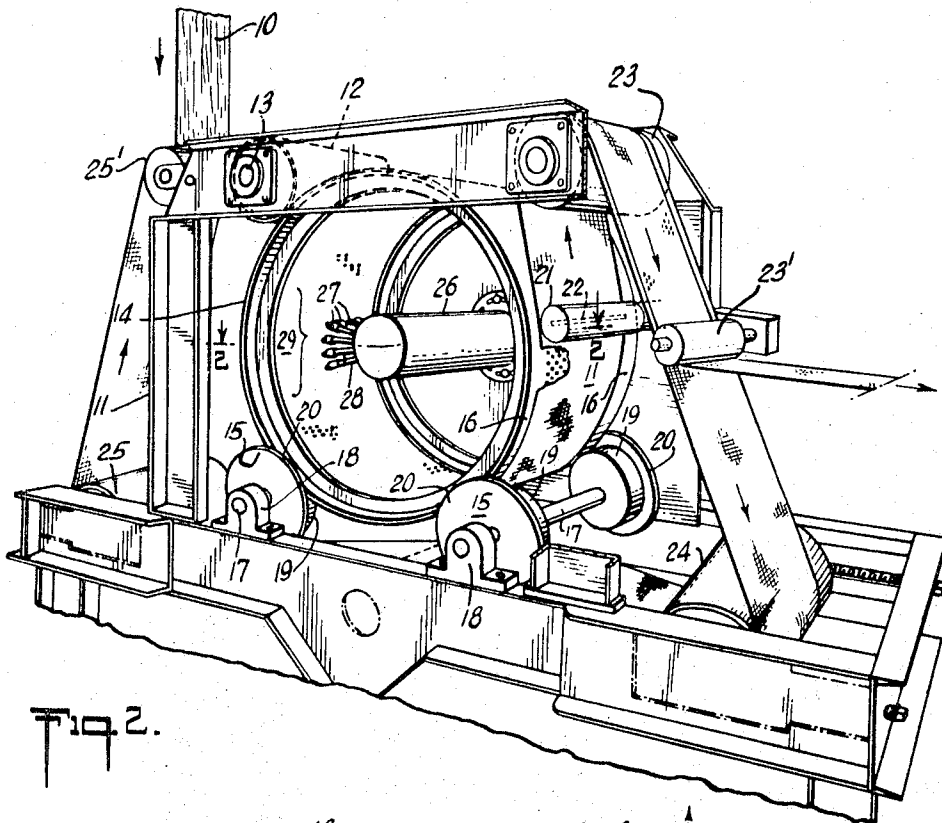
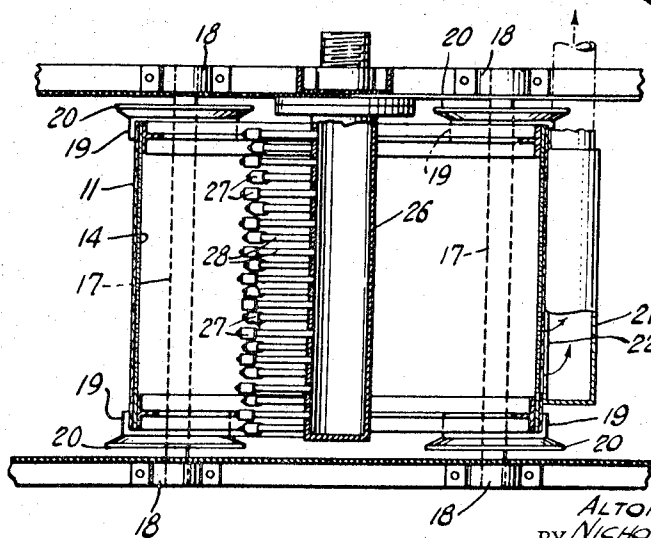


Fig. 2.



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Fig. 3.

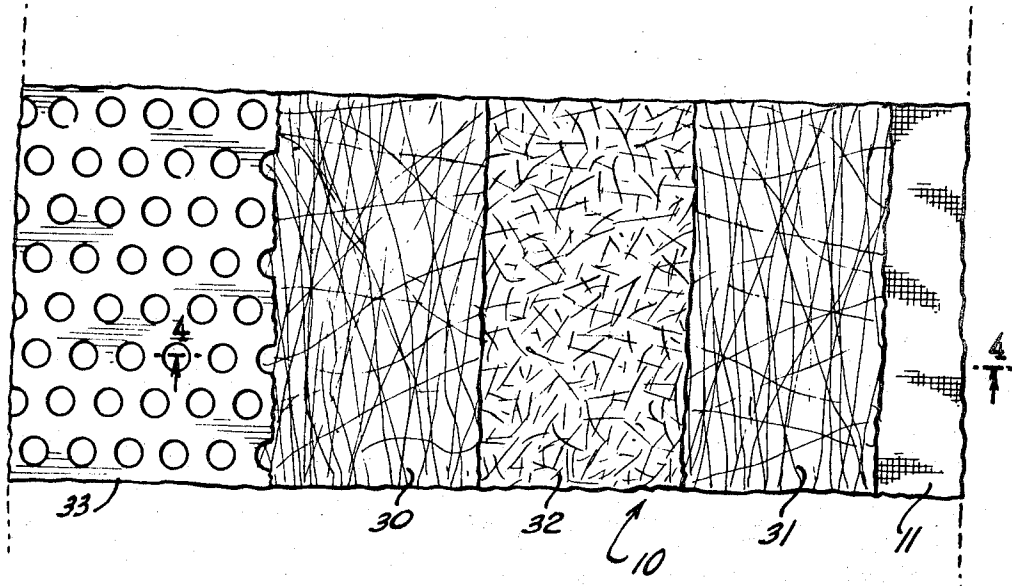


Fig. 4.

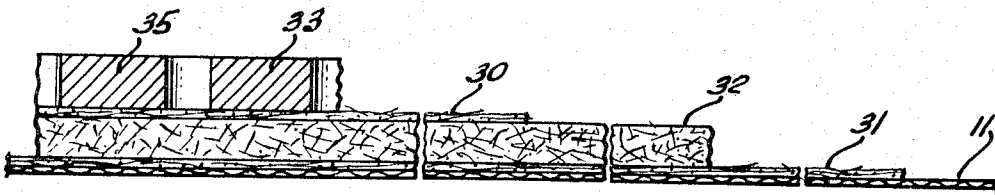
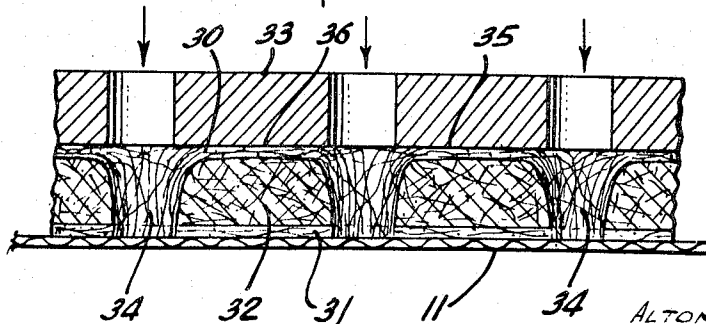


Fig. 5.



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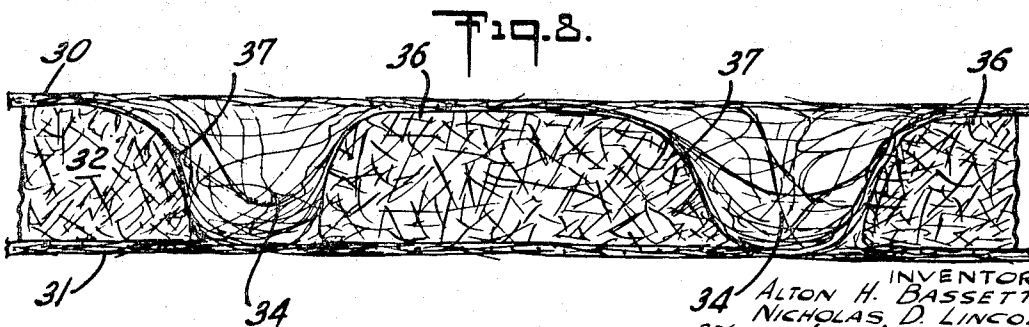
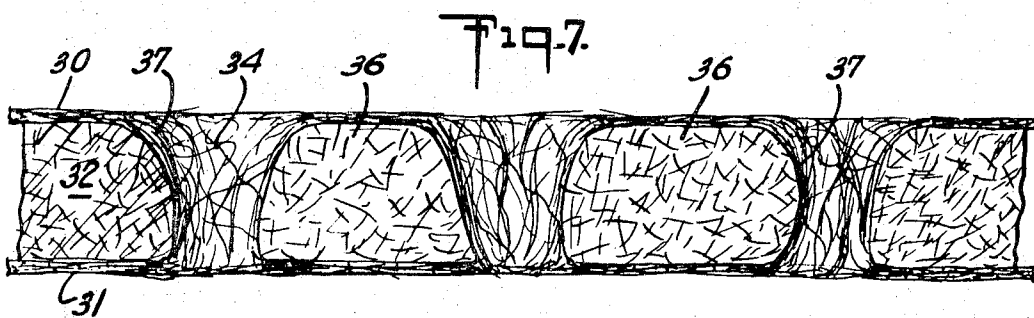
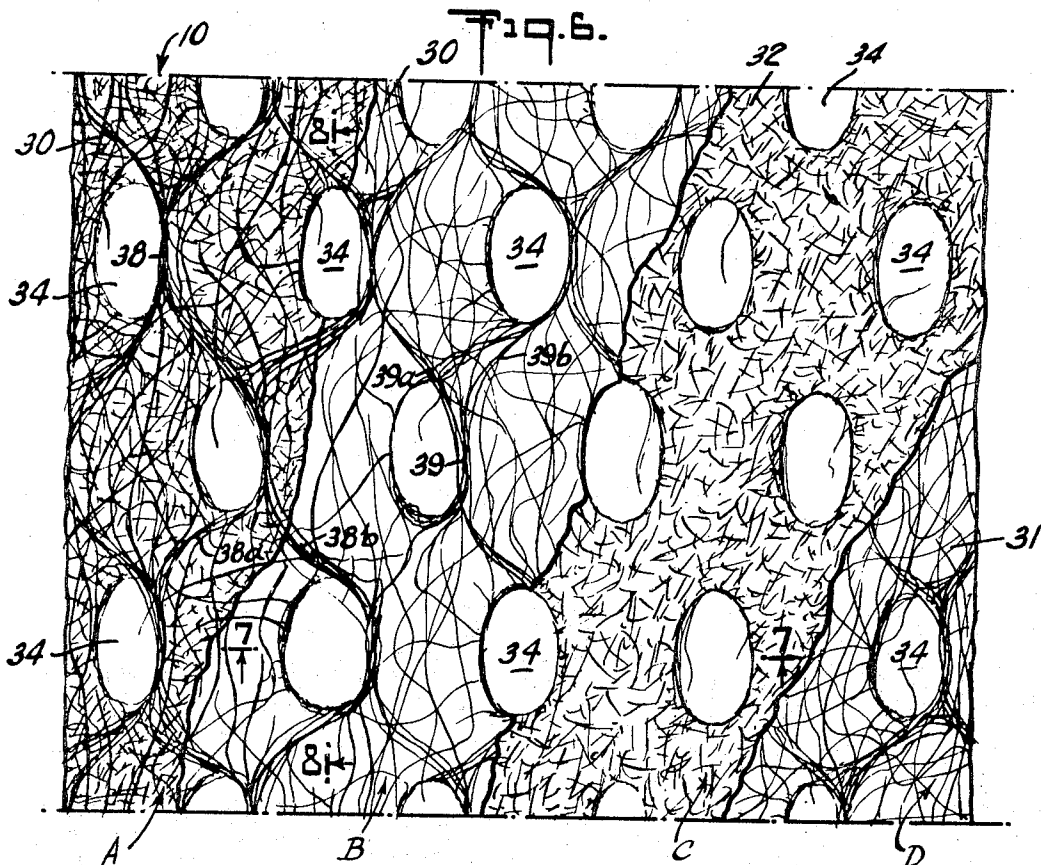
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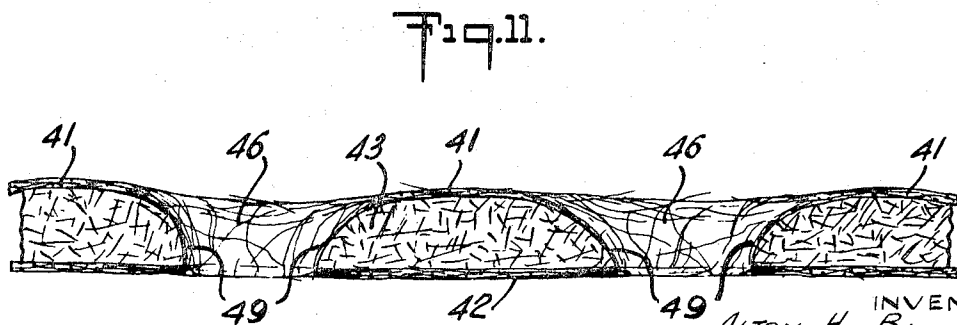
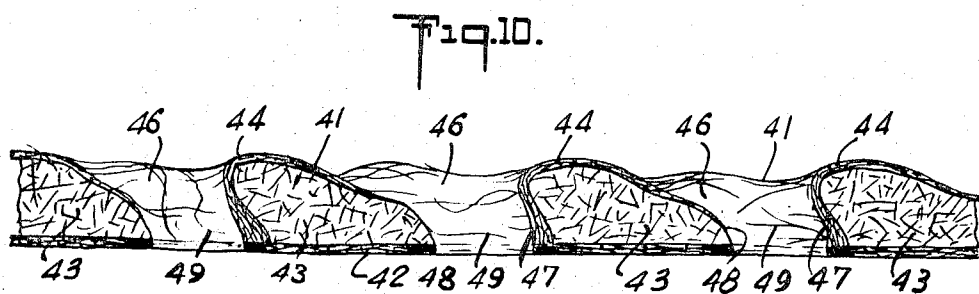
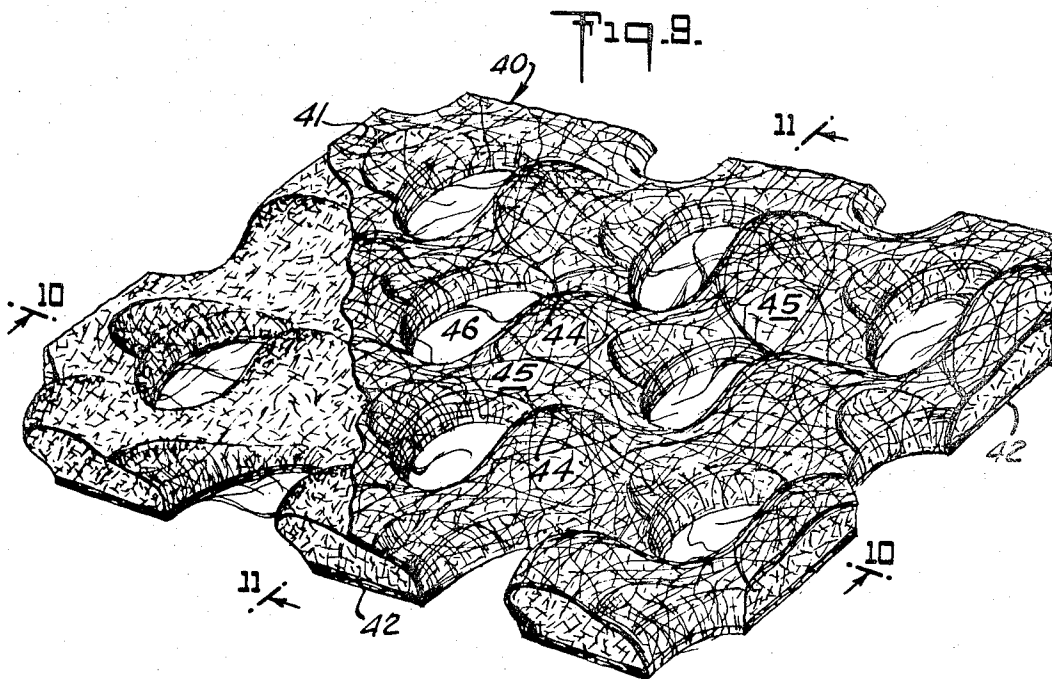
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3,336,182

NON-WOVEN COTTON WEB

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Continuation of application Ser. No. 159,951, Dec. 18, 1961. This application Sept. 22, 1965, Ser. No. 489,353
4 Claims. (Cl. 161-110)

This application is a continuation of copending application Ser. No. 159,951, filed Dec. 18, 1961, for Fabricated Product, and now abandoned. This invention relates to nonwoven fabrics and more particularly to one wherein the fibers of a web are rearranged to produce the finished product. The invention also relates to the process by which the improved product is made.

In accordance with the invention, a web of nonwoven mechanically interengaging fibers predominantly of short length, such as cotton linters by way of example, is plied together with other webs of nonwoven mechanically interconnected fibers predominantly of longer length, such as textile length fibers by way of example, and the fibers of the composite web rearranged to produce areas in which the fibers of shorter length are disposed in regions of different thicknesses with the fibers of greater length conforming to and in intimate contact with the surfaces of such regions so as to interconnect the various areas together and minimize linting out or dislodgment of the shorter fibers from the fabric.

For many uses of fiber rearranged nonwoven fabrics, substantial bulk in the fabric is greatly to be desired. Using the inventions disclosed in Kalwaites Patent 2,862,251 or those in application S.N. 92,986 filed in the name of Walter J. Hynek on Mar. 2, 1961, now Patent 3,240,657, sufficient bulk is obtainable for many uses using fibers of textile lengths. As bulk increases, however, the rearrangement of the fibers in a web of textile length fibers becomes increasingly difficult so that the efficiency of rearrangement is decreased assuming utilization of the involved processes in the normal way.

On the other hand, if a web whose fibers are to be rearranged comprises fibers of shorter length such as cotton linters by way of example, the ease of rearrangement is greatly facilitated so that rearranged webs of substantial bulk can be produced. But unless such bulky webs of shorter length fibers are impregnated with binder to an extent such that the product tends to or does become boardy, not only will such short fibers lint off, but the fabric itself will have insufficient strength for most practical purposes. Particularly if such a fabric is employed as a surgical dressing adjacent a wound, using a degree of impregnation such that appropriate softness is retained, danger is that the short fibers will lint off into the wound sought to be protected.

A fiber rearranged nonwoven fabric of heavy bulk may be produced, however, in accordance with the present invention by juxtaposing a relatively light layer of nonwoven fibers of predominantly greater length on both sides of and in face-to-face contact with a relatively bulky layer of nonwoven fibers of predominantly shorter length and simultaneously rearranging the fibers of both webs using the processes and apparatus of the above-identified patent or application. Using such processes, the longer fibers can be made to follow in intimate contact the contour of the surfaces presented by the rearranged fibers of the web of relatively shorter length thereby to bind in and prevent linting off or dislodgment of the relatively shorter fibers from the sheet of which they form a part.

Preferably the relatively bulky ply of nonwoven fibers of predominantly lesser length, interposed between two

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relatively light plies of nonwoven fibers of predominantly greater length as a "sandwich," is located in a zone defined by an apertured forming plate and a foraminous supporting belt while streams of fluid are caused to pass through the rearranging zone, entering through the apertures in the forming plate and exiting through the foramina of the supporting belt.

A better understanding of the invention may be had from the following description read in conjunction with the accompanying drawings of which:

FIG. 1 is a perspective view of a machine having utility in practicing the invention;

FIG. 2 is a partial horizontal sectional view on line 2-2 of FIG. 1;

FIG. 3 is an enlarged diagrammatic view of a portion of a fiber rearranging zone with the fabric to be rearranged in place and illustrating an apertured forming plate partially broken away to expose one layer of fibers whose lengths are predominantly within the longer range, which in turn is broken away to expose a layer of fibers whose lengths are predominantly within the shorter range, which in turn is broken away to expose a layer of fibers whose lengths are predominantly within the longer range, and which in turn is broken away to expose the underlying foraminous supporting belt member;

FIG. 4 is an enlarged sectional view on line 4-4 of FIG. 3;

FIG. 5 is a still further enlarged sectional view through a fiber rearranging zone containing a fabric in the course of being rearranged;

FIG. 6 is a plan view, much enlarged, of a fabric incorporating the invention and in which the various fibrous layers have been partially broken away to show the fibrous layers underneath;

FIG. 7 is a sectional view on line 7-7 of FIG. 6;

FIG. 8 is a sectional view on line 8-8 of FIG. 6;

FIG. 9 is a perspective view, much enlarged, of a fabric incorporating a different embodiment of the invention;

FIG. 10 is a sectional view on line 10-10 of FIG. 9; and

FIG. 11 is a sectional view on line 11-11 of FIG. 9.

The layer of fibrous material to be rearranged preferably comprises a three-ply web 10 whose outer two plies 30 and 31 are predominantly of relatively long fibers above normal paper making length and of or close to normal textile length, preferably say within the range of 18 millimeters or perhaps somewhat shorter to 50.8 millimeters or longer, and whose intermediate ply 32 is predominantly of substantially shorter fibers, for example, say fibers of paper making length (FIGS. 3 and 4). Such shorter fibers may comprise cotton linters, bleached sulfite pulp, fibers from any other wood pulp source, or fibers of equivalent length from any source.

"Pulp and Paper Chemistry and Chemical Technology," published in 1952 by Interscience Publishers, Inc., New York in Volume I at page 229 says; "Cotton staple fibers have an average length of about 18 mm. and a diameter of about 20 microns. Cotton linters are shorter and are generally not twisted. The average fiber length of cotton linters is about 6.0 to 7.0 mm. for first-cut linters, 2.0 mm. for second-cut linters, and 3.5 to 5.0 mm. for mill-run linters." The same book at pages 362 to 364 gives the average length of some paper making woody fibers. Such average lengths range from 0.85 mm. in the case of maple to 6.3 mm. in the case of redwood. Bleached sulfite pulp or wood pulp as is well known are fibrous materials from which paper is made.

The outer layers of textile length fibers may comprise natural fibers, such as cotton, flax, wood, silk, wool, jute, asbestos, ramie, "rag" or abaca; mineral fibers such as glass; artificial fibers such as viscose rayon, cupram-

monium rayon, ethyl cellulose or cellulose acetate; and synthetic fibers such as polyamides, i.e., nylon, polyesters, i.e., "Dacron," acrylics, i.e., "Orlon," "Acrilan" and "Dynel," polyethylene, vinylidene chloride, i.e., Saran, polyvinyl chloride, polyurethane, etc., alone or in combination with one another. Satisfactory fabrics of rearranged fibers may be produced according to this invention, ranging from between 700 grains per square yard or lower and 6000 grains per square yard or higher. Of this, by far the greater weight and bulk is accounted for by the fibers within the shorter range which, of course, are the most economical—the formation of an economical sheet being one of the main desiderata of the invention. As to the outer layers of textile length fibers, the minimum weights of each layer used should be of the order of approximately 90 grains per square yard. Higher weights may be used but to give an upper limit to the weight of the outer layers of textile fibers would have little meaning since the utility of the invention is most fully realized when such layers are of minimum weight consistent with their ability to perform their intended function.

The fibrous webs used in practicing the invention comprise mechanically interengaging fibers, in a state of equilibrium, such as may be formed, depending upon their length, by carding, garnetting, air laying by techniques such as are disclosed in U.S. Patent 2,676,364, and by paper making techniques, etc.

In fabricating the improved product, a layer 32 of the shorter length fibers is preferably sandwiched in between two layers 30, 31 of the longer length fibers to form a web laminate 10 which is led from a suitable source, not shown, and deposited on a flexible conveying belt support 11 just somewhat in advance of where the belt passes over a horizontal guide roller 12 fixed on a shaft 13 which is journaled for rotation at its opposite ends in the side frame members of the machine (FIGS. 1 and 2). The web, as it is carried by the belt support passes around the guide roller 12 and then is sandwiched between the belt and a relatively large cylindrical drum 14 around which the belt passes and whose axis is parallel with the axis of the guide roller and which is cradled for rotation about its own axis on two pairs of spaced flanged discs 15 disposed near the bottom of the drum. The cylindrical drum 14 is longer in an axial direction than the width of the web supporting belt 11 so that there is a cylindrical marginal portion 16 at each end of the drum that remains uncovered by the web supporting belt in its travel around the drum. The discs 15 of each pair are fixed near the opposite ends of a shaft 17, disposed parallel with the drum's axis in the machine frame. These discs present cylindrical portions 19 to accommodate the marginal end portions of the drum and radial disposed flanges 20 which overlap the opposed peripheral edges of the drum, so as to prevent movement of the drum in an axial direction laterally of the machine. The spacing between the shafts 17 of the respective pairs of discs in a direction fore and aft of the machine (i.e., the direction of web travel) is sufficient to cradle the drum with appropriate stability during its rotation.

As the drum 14 rotates through the drive of the belt 11, as will be later explained, the drum and belt with web 10 sandwiched therebetween travels as a unit without relative movement in the direction of travel through a drum rotation of about 240 degrees, i.e., from the initial guide roller 12 near where the web is first received by the belt, down and around the drum and up to a position substantially level with or perhaps somewhat above the level of the drum axis where the belt and web supported thereon are taken off the drum. The web laminate, during this travel, passes through a fiber rearranging zone, described in greater detail later on, where it is subjected to the action of the rearranging fluid. If the fluid used is water, the web after fiber rearrangement has a substantial amount of its entrained moisture removed by passing in close proximity to a dewatering device which may be

in the form of a chamber 21 connected to a source of vacuum not shown and provided with a longitudinal slot 22 extending from one edge of the supporting belt to the other and in axial parallelism with the drum. Such a device may serve to diminish web moisture to about 150 percent in a web containing 1200 percent, and to effect withdrawal of the web from the drum 14, the web and belt thereupon proceeding upwardly and around another guide roller 23 fixed on a shaft journaled in bearings in the side frame members of the machine and which is in axial parallelism with the drum. From the guide roller 23, the supporting belt with web travels downwardly past still another similarly supported guide roller 23' where the web 10 leaves the supporting belt.

The supporting belt 11, after its divorce from the web 10, travels downwardly and around two guide rollers 24, 25, both axially parallel with the drum axis and which are located one near the rear and the other near the front of the machine. From the latter roller, the supporting belt 11 travels up to a guide roller 25' and then horizontally to the initial guide roller 12, ready again to support and carry a new section of the fiber web 10 through the machine and render the process continuous. The drive of the drum, incidentally, is through the belt support 11 which in turn may be driven from the guide roller 24. Roller 24 for this purpose may be suitably connected with a motor, not shown.

Of the same axial length as the drum and fixed coaxially within it is a manifold 26, closed at one end but provided at the other end with appropriate fittings through which a rearranging fluid, such as water, may be introduced under pressure. Fluid, preferably in the form of streams of liquid droplets, is projected toward the inner surface of the cylindrical drum 14 from appropriate conventional nozzles 27 disposed at the ends of tubes 28 which communicate with the manifold and extend radially therefrom. The tubes 28 are arranged in banks extending along the manifold 26. Two such banks at least are preferred, and sometimes three, four or even more may be desirable to increase speed of operation. However, as will be observed, the nozzle-ended tubes are all directed generally in the same direction so as to encompass within their range of action, a relatively minor portion 29 only of the interior circumferential surface of the drum.

The belt support 11 is pervious to fluid, e.g., water, and is foraminous, possessing openings varying from about 900 openings per square inch to about 50,000 openings per square inch or more, preferably from about 10,000 to 40,000 openings per square inch. The smoothness or evenness of the backing means or screen affects the production of the rearranged fabric, the finer screens tending to possess greater smoothness and thereby more readily to facilitate motion of the fibers along its surface.

The foraminous backing means may be made of any suitable material. A screen belt in woven form gives excellent results. However, a woven belt is not essential since the belt may have openings punched or etched in the material. The belt, in screen form, may be made of stainless steel, bronze, copper, alloy, nylon, synthetic resinous fibrous materials such as sold by the E. I. du Pont Co., under the trademark "Orlon," or the like. It can be in the form of a flexible punched plate of steel, plastic or other material which is sufficiently foraminous to allow passage of the fluid but sufficiently impervious and smooth to permit the action of the fluid to effect the desired rearrangement of the fibers over its surface without washing them away.

Suitable devices, of no concern with this invention, may be used to adjust the tension in the supporting belt 11 and its location laterally with respect to the guide rolls and drum.

Except for a few specific details which will be evident from what has been said, the apparatus used in practicing the invention as thus far described is old and refer-

ence may be had to Kalwaites 2,862,251, supra, if greater details of construction are desired.

The drum 14 through which the fluid passes in effecting the rearranging process has a cylindrical wall which may be an apertured plate 33, as described in the Kalwaites patent referred to, or may be formed with a pattern of protrusions with tapering passageways through which the fluid is conducted at an angle to the surface of the web to be rearranged as described in the previously referred to Hynek application S.N. 92,986. In the former instance, the resulting rearranged web presents a pattern of holes defined by interconnected fibrous areas of different heights but which have regions of the same maximum height extending continuously throughout such areas, whereas in the second case the resulting rearranged web presents a pattern of tubercles interconnected by regions of varying heights in which there is also a pattern of holes.

As shown in FIGS. 3 and 4, the fibrous web 10 with its three plies 30, 31 and 32, is supported between the flexible foraminous belt 11 and the apertured plate 33 of the drum as it passes through the fiber rearranging zone. As previously stated, it comprises an inner relatively thick ply 32 of the desired weight of mechanically interengaged nonwoven short fibers and, preferably, two outer plies 30 and 31 of mechanically interengaged nonwoven longer fibers. Such outer plies both may be isotropic, both carded, one isotropic and one carded, and if carded, the fiber orientation in each ply may be the same or different and in either case predominantly in the direction of travel of the web through the machine or predominantly in a direction transverse to the travel of the web through the machine.

As shown in FIG. 5, the fluid, whether it be water, steam, or air, is projected through the apertures in the plate 30, through the fibrous layer 10 and through the foraminous supporting means 11. As the streams pass through the fibrous web, the fibers are moved out of the way and into regions between the streams to form a foraminous structure comprising openings or holes 34 arranged in a pattern corresponding in general with the pattern of holes in the apertured plate 33. During the rearrangement of the fibers, there is very little tendency on the part of the fibers of one ply to intermingle with the fibers of the other plies.

To be more explicit, the stream of fluid, probably most generally water, will pass in turn through the apertures of the plate 33, the first ply 30 of longer fibers, the intermediate ply 32 of shorter fibers, the second ply 31 of longer fibers and then the foraminous belt 11. The tendency, of course, is to wash the fibers in the second ply of longer fibers away from the other plies and this perhaps would occur were it not for the foraminous belt 11. The fibers in the second ply of longer fibers are moved aside to form areas of low fiber concentration or holes but such movement of fibers is along and adjacent to the foraminous belt so that this ply remains as a backing member for the fabric and in a sense functions during manufacture of the fabric somewhat similar to the foraminous belt insofar as rearrangement of the short fibers in the intermediate layer is concerned. The short fibers in the intermediate layer wash out of the paths of the streams and into those areas or localities disposed immediately below lands 35 between the apertures in the forming plate. These lands are all in the same cylindrical surface in this embodiment of the invention and consequently the crests 36 of these areas between the holes 34 of the rearranged fabric are continuous throughout the surface of the fabric and in the same plane. From these crests of the areas between the holes are regions 37 which slope more or less steeply down to the bottom of the fabric or what may be considered the same thing, the bottom ply 31 of long fibers adjacent the foraminous belt 11.

The long fibers in that layer 30 on the face of the composite web opposite the foraminous supporting belt

11 and adjacent the apertured forming plate 33, have portions thereof that have washed down into the apertures 34 formed in the intermediate layer 32 of shorter length fibers. These longer fibers under the action of the fluid streams drape themselves over, along and in close contact with the surfaces of the areas between the apertures and, in general, are close enough together to restrain dislodgment of the short fibers from the walls of the holes as well as from the surface of the crest areas which in the formation of the sheet are next adjacent the underlying surface of the apertured forming plate. These longer fibers extend out of one hole over an intermediate portion of the web of shorter fibers and down into a second hole, and from there again over an intermediate portion of the web of fibers to still a third hole, and perhaps a fourth or more.

From FIG. 6, it will be noted that a group 38 of long fibers leaving one hole may pass as a group to a second hole, and then split, passing one portion 38a of the group from the second hole to a third hole and another portion 38b of the group to still a fourth hole. Groups 39a and 39b of long fibers from different holes may combine into a single group 39 to enter a third hole. Groups of fibers or individual fibers in traversing the fabric from hole to hole may remain as groups or as individual fibers. Individual fibers may pass into groups of fibers and then again assume their individual identities. Such arrangement of fibers while haphazard and not in pattern nevertheless will occur with sufficient frequency effectively to anchor the shorter length fibers in the intermediate layer and between the holes thereof against any appreciable linting or dislodgment out of the fabric.

While in no sense intended to be limiting, the advantages of the invention may be most effectively utilized if the weight of the top ply with long fibers is such that the distance between their individual fibers after fiber rearrangement is somewhat less than the average length of the shorter fibers in the intermediate ply. With that construction, the surface of the intermediate ply of rearranged fibers is visible between the rearranged longer fibers of the top ply and thus such longer fibers will not detract from those qualities of absorbency, etc., possessed by a pure linters sheet in the absence of the longer binding fibers.

In FIG. 6, there is illustrated at the extreme left of the figure, a section A having the appearance of the rearranged composite fabric of the invention viewed in plan. A portion of the fabric B first to the right of section A illustrates how the long fibers in the ply 30 would appear after rearrangement were it possible to remove the shorter length fibers without disturbing the fibers of greater length. A section C to the right of section B illustrates how the short fibers in the intermediate ply 32 would appear in the absence of the binding fibers of ply 30, and in a section D furthest to the right there is illustrated in plan the layer 31 of longer fibers on the opposite side or bottom of the sheet as they would appear if the shorter fibers in the intermediate ply 32 and the longer fibers of the top ply 30 were removed.

FIG. 7 which is a cross section through the fiber rearranged fabric of FIG. 6 looking along the line of machine travel, and FIG. 8 which is a similar cross section but looking in a direction transverse to the direction of machine travel, show how the longer fibers of the ply 30 pass down into the holes between the various areas or regions of shorter fibers in ply 32 and in intimate contact with the surfaces of such areas to perform their function of binding-in the short fibers.

In FIG. 9 there is shown in perspective magnified about 20X, another embodiment of a three-ply fabric 40 of which two outer light weight plies 41, 42 have relatively long fibers and an inner heavier weight ply 43 has relatively short fibers. The fibers in the composite web are illustrated as having been rearranged in accordance with the processes described in the Hynek

application S.N. 92,986 previously referred to. A fabric so formed presents a pattern of tubercles 44 interconnected by fabric portions 45 presenting a pattern of holes 46. Such interconnecting fabric portions vary in thickness ranging from the thicker portions adjacent the crest of the tubercles to the thinnest portions adjacent the holes. As clearly described in Hynek's copending application, the forming plate through which the fluid is caused to impinge upon the layers of fibers (two outer plies of relatively long fibers and one intermediate ply of relatively short fibers or linters) has its holes or passageways entering the fiber rearranging zone at an angle to the face of the fabric so that the holes as formed in the rearranged fabrics are disposed at substantially the same angle.

As shown in FIG. 9, the longer fibers in the top and bottom plies 41 and 42 travel from one hole to another over the intervening interconnecting areas of fibers in the same manner as they do in a fabric made in accordance with Kalwaites' method previously described. The longer fibers in the top ply and in the bottom ply closely follow the configuration of the surface presented by the fibers in the intermediate ply. However, in rearranging fibers according to Hynek's process, there is produced a component of fluid force acting say widthwise of the fabric, as a result of the fluid entering the rearranging zone at an acute angle. This fluid force may act to undercut the tubercles at the downstream edge of the hole but to leave a more gradual descent in the surface from the crest of the tubercle to the edge of the hole on the upstream side thereof. Thus, there may be a greater accumulation 47 of longer fibers of the top ply on the downstream edge of the hole beneath the undercut portions of the intermediate ply with a lesser accumulation 48 of fibers adjacent the upstream edge of the hole (FIG. 10). Transverse to the direction of fluid flow, however, the accumulation 49 of longer fibers is substantially uniform (FIG. 11).

In the layer of textile length fibers 42 adjacent the bottom of the fabric, long fibers are disposed substantially uniformly in the areas thereof in contact with the regions of shorter fibers. But, again in the regions adjacent the holes there may tend to be an accumulation of such fibers at the downstream side of the hole and a thinning out of the fibers on the upstream side of the hole. However, and as in the case of the fibers in the top ply, the fibers in the bottom ply are in intimate association with the surface areas of the intermediate ply so that these short fibers are restrained against a tendency to lint off or become dislodged out of the fabric.

From what has been said, it will be apparent that the invention in essence contemplates a fabric having a relatively bulky layer of mechanically interengaged, closely associated nonwoven fibers whose surface presents a pattern of fabric areas in which the layer thickness varies and whose fibers possess lengths predominantly within a shorter range. The fabric further comprises mechanically interengaged predominantly longer nonwoven fibers, as for instance fibers of textile lengths, interconnecting the different areas of short nonwoven fibers and conforming closely to the surface configurations of the layer of short fibers, and which are sufficiently close together effectively to restrain the shorter fibers from linting out.

After the fabric has been formed, it is treated with a binder for strength and while the binder may be distributed uniformly throughout as by overall impregnation, the structure of the improved fabric is such that the binder may be in the form of a print pattern in which much of the area of the fabric is left free of binder so that the surface of the fabric reflects the normal characteristics of the fibers in the absence of a binder.

Example I

A fabric having surgical application such as for the absorbent pad of an adhesive bandage may be made from a three-ply fibrous web laminate containing viscose

rayon textile fiber webs for the outer face binding layers and cotton linters for the center core. Each face web may be a 90 grains per square yard blend of 75 percent extra dull and 25 percent regular dull rayon fibers of 1½ denier and 2 inch staple length. The core may be a 2,275 grains per square yard sheet of bleached cotton linters prepared so as to be of low density with minimum hydration bonding. The fibers of this web laminates may be rearranged using a raised surface forming drum, in accordance with methods described in the Hynek application and which produce a fabric such as that shown in FIGS. 9, 10, and 11. For this fabric, a drum may be used having approximately 50 holes per square inch and of a size such that 16½ percent of the drum's surface is open area.

After fiber rearrangement and vacuum extraction of the fluid, the web may be printed with an appropriate binder using an intaglio printing cylinder having 4 wavy line printing depressions to the inch with the printing depressions each being .024 inch wide and .010 inch deep. The printing is done first on one side and then on the other, without effort being made to cause the print lines on opposite sides of the sheet to be in register. The amount of binder thus applied adds approximately 45 grains per square yard to the weight of the fabric so that the finished product is approximately 2500 grains per square yard. This fabric appropriately treated will serve as an excellent pad for an absorbent adhesive bandage as previously mentioned.

Example II

Using the same methods of fiber rearrangement as described in connection with Example I, a fabric suitable for a wash cloth or a wipe cloth can be made using for each face web a 150 grains per square yard blend of 50 percent rayon of 1½ denier, 2 inch staple length extra dull luster, and 50 percent bleached absorbent cotton. The interposed layer may be a 4700 grains per square yard special bleached cotton linters of low density. A suitable drum would have approximately 14 holes per square inch with hole diameter of .098 inch. For this fabric, the bonding would constitute saturation with a self cross-linking acrylic emulsion with a solids percentage and pickup arrangement such that the final product contains 1000 grains of binder solids. A fabric thus made weighs approximately 6000 grains per square yard and is quite suitable for the uses previously mentioned.

The invention has been described in connection with preferred embodiments thereof but many modifications are included within its spirit and should be limited, therefore, only by the scope of the appended claims.

What is claimed is:

1. A nonwoven fabric comprising a relatively bulky intermediate fibrous layer of interconnecting closely associated shorter nonwoven fibers with average lengths substantially within the range of cotton linters and pulp wood fibers and predominantly not longer than 7.0 millimeters, said fibrous layer presenting holes arranged in a predetermined pattern over the surface area of said layer, and relatively thinner outer layers of longer textile length fibers with average lengths predominantly not less than 18 millimeters disposed adjacent the opposite faces of the bulky intermediate layer, said longer fibers having close contact with said intermediate layer substantially only along its surfaces and in the areas of the surfaces between the holes and within the holes, and said longer fibers being sufficiently close together effectively to bind in the shorter fibers and restrain them from linting out between the longer fibers.

2. A nonwoven fabric comprising a relatively bulky intermediate fibrous layer of interconnecting closely associated nonwoven fibers with average lengths substantially within the range of cotton linters and pulp wood and predominantly not longer than 7.0 millimeters, said fibrous layer presenting holes arranged in a predeter-

mined pattern over the surface area of said layer, and relatively thinner outer layers of longer fibers with average lengths predominantly not less than 18 millimeters disposed adjacent the opposite faces of the bulky intermediate layer, said longer fibers having close contact with the said intermediate layer substantially only along their surfaces and in the areas of the surfaces between and within the holes, and said longer fibers extending some throughout areas of the fabric defining including a plurality of holes and being sufficiently close together effectively to bind in the shorter fibers and restrain them from linting out between the longer fibers.

3. A nonwoven fabric comprising a relatively bulky intermediate fibrous layer of interconnecting closely associated shorter nonwoven fibers with average lengths substantially within the range of cotton linters and pulp wood fibers and predominantly not longer than 7.0 millimeters, said fibrous layer presenting holes arranged in a predetermined pattern over the surface area of said layer, and relatively thinner outer layers of longer textile length fibers with average lengths predominantly not less than 18 millimeters disposed adjacent the opposite faces of the bulky intermediate layer, said longer fibers having close contact with said intermediate layer substantially only along its surfaces and in the areas of the surfaces between the holes and within the holes, and some of said longer fibers extending some from one hole to a plurality of other holes and being sufficiently close together effectively to bind in the shorter fibers and restrain them from linting out between the longer fibers.

4. A nonwoven fabric comprising a relatively bulky

intermediate fibrous layer of interconnecting closely associated shorter nonwoven fibers with average lengths substantially within the range of cotton linters and pulp wood fibers and predominantly not longer than 7.0 millimeters, said fibrous layer presenting holes arranged in a predetermined pattern over the surface area of said layer, and relatively thinner outer layers of longer textile length fibers with average lengths predominantly not less than 18 millimeters disposed adjacent the opposite faces of the bulky intermediate layer, said longer fibers having close contact with said intermediate layer substantially only along its surfaces and in the areas of the surfaces between the holes and within the holes, and said longer fibers extending some from a first hole to another hole and others from said first hole to yet a different hole and being sufficiently close together effectively to bind in the shorter fibers and restrain them from linting out between the longer fibers.

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