Sept. 29, 1964 J. J. SUCH 3,150,416

METHOD AND APPARATUS FOR PRODUCING APERTURED NON-WOVEN FABRICS

Filed July 29, 1960 3 Sheets-Sheet 1

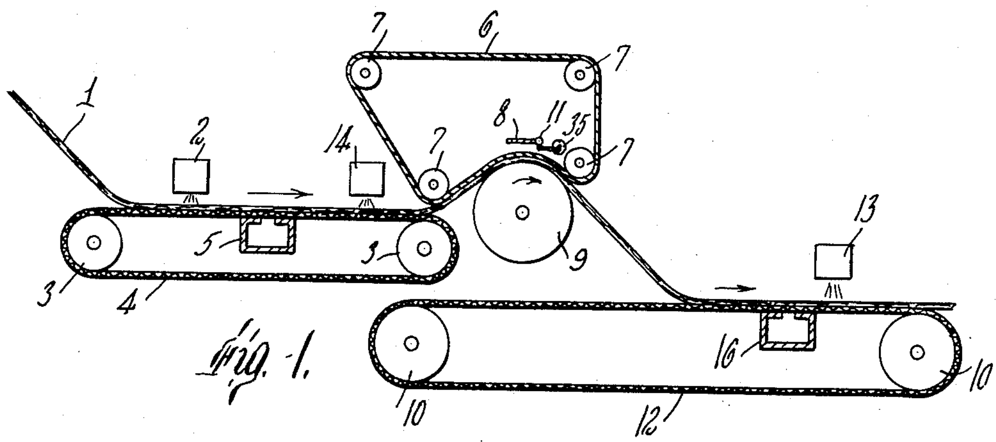

Fig. 1.

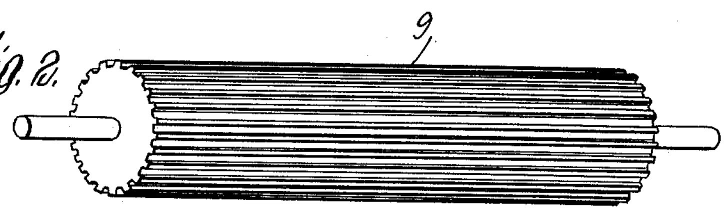

Fig. 2.

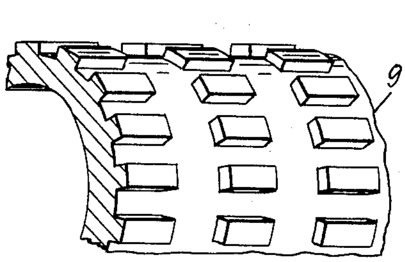

Fig. 3.

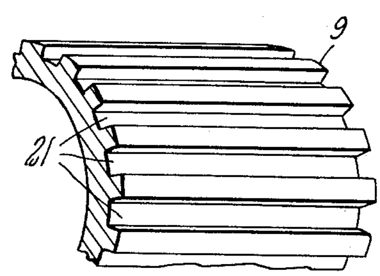

Fig. 4.

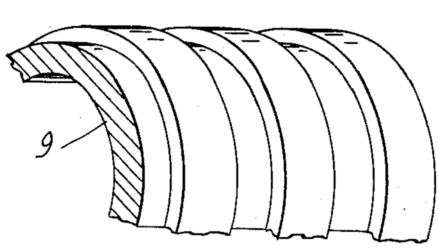

Fig. 5.

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METHOD AND APPARATUS FOR PRODUCING APERTURED NON-WOVEN FABRICS

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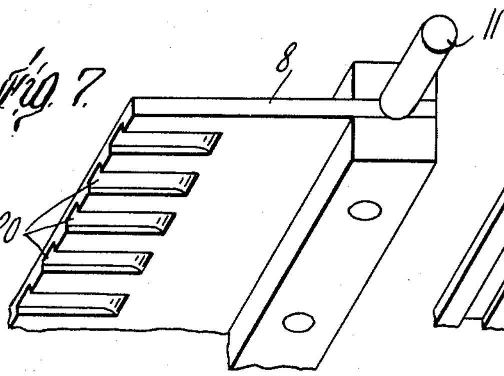
Fig. 7.



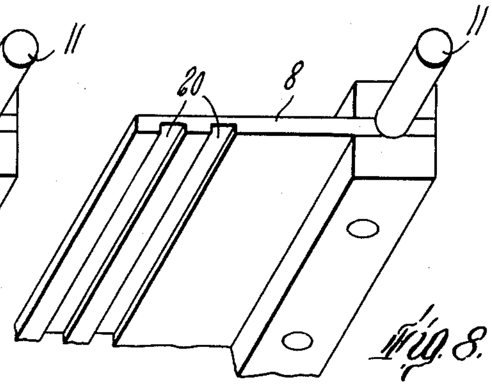
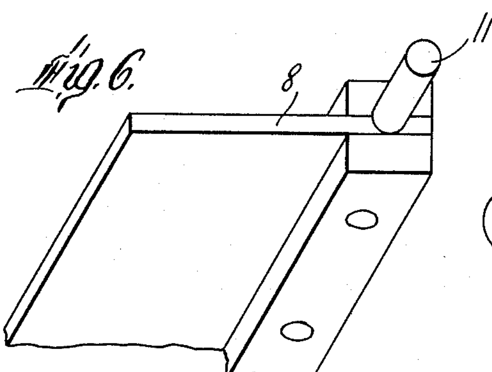


Fig. 8.

Fig. 6.



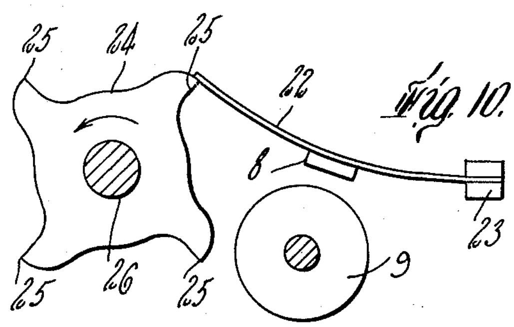
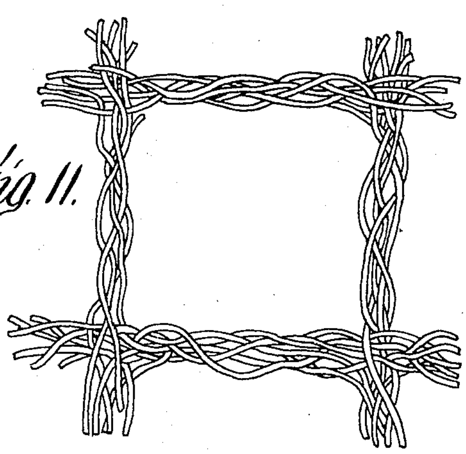


Fig. 10.

Fig. 11.



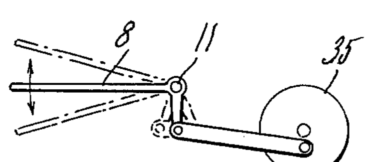


Fig. 9.

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METHOD AND APPARATUS FOR PRODUCING APERTURED NON-WOVEN FABRICS

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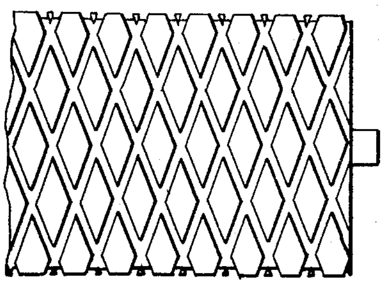

Fig. 12.

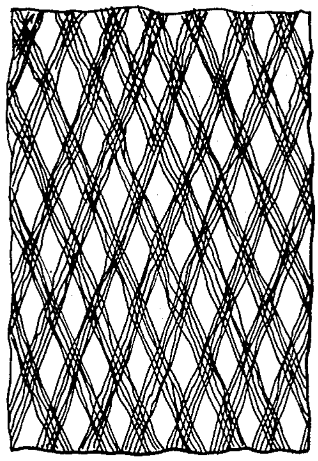

Fig. 13.

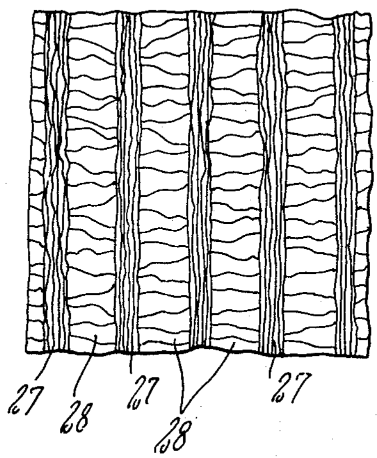

Fig. 14.

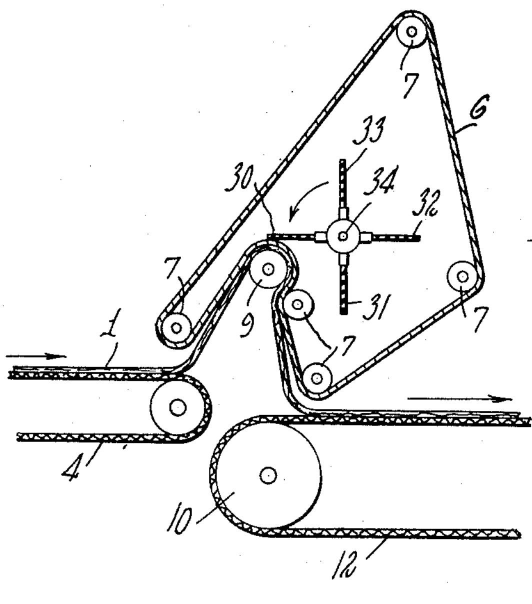

Fig. 15.

United States Patent Office 3,150,416
Patented Sept. 29, 1964

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3,150,416
METHOD AND APPARATUS FOR PRODUCING APERTURED NON-WOVEN FABRICS

John J. Such, Wrentham, Mass., assignor to The Kendall Company, Boston, Mass., a corporation of Massachusetts

Filed July 29, 1960, Ser. No. 46,129
8 Claims. (Cl. 19—161)

This invention relates to novel non-woven fabrics, and to a method and apparatus for the manufacture thereof. More particularly, it relates to a method and apparatus for producing a non-woven fabric which more or less closely simulates woven fabrics, in that its fibers are rearranged into interconnecting groups which define apertures resembling the interstices found between the yarns of woven cloth.

By non-woven fabrics I refer to a unified array or sheet of fibers which have been integrated into a self-sustaining condition without the exercise of conventional spinning and weaving operations. Such fabrics are well known in the art, particularly in recent years, and are commonly made by bonding together some or all of the fibers in a multi-ply card web assembly with a liquid binding agent. Alternative methods of web formation are also used, such as garnetts, air-lay machines, and the like. Also it is known to use, instead of a liquid binder, thermoplastic fibers, dry powders, or other bonding techniques. The bonding may be conducted so that the entire web assembly contains binding material, or so that only selected discrete areas are bonded, in the form of lines of binder running across the web, or dots of binder so interspaced as to create a desired effect.

The present invention is not primarily concerned with the methods of assembling fibers into a web, nor with bonding techniques, since the process of the invention is applicable to webs prepared by any of the known web-making techniques, and the product of the process may be bonded by any of the methods now in use in the art.

It is generally recognized that conventional non-woven fabrics, although well suited for numerous industrial and consumer uses, are inferior to woven fabrics in applications where high porosity is a requisite or where an open, semi-transparent gauze-like effect is necessary. Attempts have been made to overcome this solid-sheet or paper-like appearance by processes which thrust pins through the base fibrous web before or during bonding, or by using hydraulic jets to force the fibers into an aligned, ramified approximation defining holes or apertures. It is with a new realigning or rearranging process for fibrous arrays that this invention is concerned.

It is an object of this invention to provide a process whereby a fleece or web of fibrous material of substantially uniform density may, by mechanical manipulation, undergo rearrangement so that the fibers are aggregated into yarn like structures.

It is a further object of this invention to provide a process and apparatus for the production of open-meshed interconnected groupings of unspun fibrous bundles from a substantially uniform sheet of textile fibers.

It is a further object of this invention to provide a process and apparatus for the production of a lightweight apertured gauze-like non-woven fabric, suitable for many of the uses to which surgical gauze is commonly put.

Further objects of the invention will appear hereinbelow.

In general, this invention relates to the forced redistribution of fibrous matter under the repeated application of multiple mechanical impacts imparted to the fibrous matter while it is supported on a patterned or grid-like array. This grid-like array is so contrived that it consists of high spots or lands, and an array of grooves or valleys into which the fibers are manipulated by the repeated impacts. To minimize inter-fiber friction, and to facilitate rearrangement, the fibrous array is customarily wet with water or other lubricating or swelling agent prior to being impacted.

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Impacting may conveniently be carried out by subjecting the wet fibrous web to the action of a smooth or grooved paddle, as described more fully below.

The invention may be more clearly understood by reference to the accompanying drawings, in which:

FIGURE 1 is a diagrammatic side elevation view of a preferred apparatus of this invention.

FIGURE 2 is a perspective view of the forming roll, **9**, of FIGURE 1.

FIGURE 3 is a perspective view of a section of a modified forming roll.

FIGURE 4 is a perspective view of a section of the forming roll of FIGURE 2.

FIGURE 5 is a perspective view of a section of another modification of the forming roll.

FIGURE 6 is a perspective view of a section of a non-configured impacting device.

FIGURE 7 is a perspective view of a section of a laterally-grooved modification of an impacting device.

FIGURE 8 is a perspective view of a section of a transversely-grooved modification of an impacting device.

FIGURE 9 is a diagrammatic side elevation of a conventional mechanism, such as a textile card "comb box" drive, designed to convert rotary motion to oscillating motion, suitable for use as drive mechanism **35** for the shaft **11** of FIGURE 1.

FIGURE 10 is an elevation of an alternative type of impacting device.

FIGURE 11 is a perspective view, considerably enlarged, of the state of aggregation of fibers in a typical product made by the apparatus and process of this invention.

FIGURE 12 is still another modification of the forming roll.

FIGURE 13 is a non-woven product made using the forming roll of FIGURE 12.

FIGURE 14 is another embodiment of a product made according to this invention.

FIGURE 15 is an alternative impacting device for the practice of this invention.

Referring to the accompanying figures in more detail, in FIGURE 1 there is shown a sheeted array of fibers, **1**, supported on a conventional conveyor screen **4**, driven by the drive rolls **3**. The array of fibers may be formed by any conventional means, not shown, such as by carding or garnetting, or by means of an air-layering apparatus.

As the fibrous array is conveyed on the conveyor screen **4**, it is moistened with water, dilute binder solution, swelling agent, or any desired fluid serving to facilitate the subsequent separation of fiber from fiber to form a type of reticulated or grid-like array. Moistening may be accomplished by the device shown at **2**, FIGURE 1, which may be any of a number of means such as a spray arrangement, transfer roll, flooder, or any conventional device for moistening the array. For economy's sake, when a binder solution or swelling agent is applied at moistening means **2**, the amount of applied medium is rather closely controlled, and application is preferably in the form of a finely-atomized low-pressure mist or spray. If water is the saturant, the moistening means **2** may conveniently be a conventional flood box. In this case, an excess of water is usually applied at moistening means **2**, and the moisture content is adjusted to around 800% to 1500%, based on the weight of the fiber, by means of the suction box 5, of conventional nature. This amount of 800% to 1500% of water has been found to enhance fiber reorientation under repeated percussive impact.

Another applicator device, shown as a set of spray nozzles **14** in FIGURE 1, is for the purpose of applying a controlled amount of binder or swelling agent, if desired, in cases where the web or fibrous array has been wet only with water up to this point. Alternatively, a binder may be supplied to the fibrous array by means of the applicator nozzles **13**, situated after the aperture-forming section. If desired, incremental amounts of fluid binder, or different binders, may be applied at the applicator stations **2**, **14** and **13**. Multi-stage applications allow the application of a curable binder at one stage and a separate application of curing agent or catalyst at a subsequent stage, thus avoiding mixing of binder and catalyst in the applicator system.

The fibrous array, in a wet condition, passes from the end of the conveyor screen **4** over a forming roll, **9**, shown in more detail in FIGURES 2, 3, 4, and 5. As the wet array passes over the forming roll **9**, it is subjected to a rapid series of blows from an impacting device such as the flexible paddle **8** mounted on a reciprocating shaft **11**, driven by an oscillatory mechanism **35**.

As described in more detail hereinbelow, this rapid vibratory impact motion, preferably substantially normal to the plane of the fibrous web, results in effectively moving the hitherto more or less uniformly distributed fibers in the array to the points of greatest security against further dislodgement—i.e., the fibers are forced down off the flat-topped lands and into the grooves or valleys of the patterned forming roll.

For protection against unwanted distortion of the reticulated fibrous pattern, it is preferred to interpose a protective membrane between the wet fibrous array and the impacting paddle. For this purpose, a thin flexible sheet of plastic material, **6** in FIGURE 1, such as rubber, nylon, Mylar film, polyethylene, etc., may be brought into contact with the wet fibrous array by means of a set of driven rollers **7**, said plastic film being formed into an endless belt traveling around said set of driven rollers. This protective membrane is not always an essential part of the apparatus or process, but is recommended where very fine definition of apertured pattern is desired, or where freedom from minor defects and irregularities is a criterion.

As shown in FIGURE 1, a convenient type of impacting device is a flexible paddle **8** mounted as a cantilever on shaft **11**, driven by any suitable mechanism **35** which will cause the shaft, and thereby the attached paddle, to oscillate in an oscillating rotary motion through an arc of about 60°. It will be appreciated that an angular displacement of 60° is illustrative and by no means critical to the proper functioning of the impact blade or paddle. Displacements which deviate substantially from 60° may be used, provided that the periodicity of the stroke is adjusted to supply sufficient reorienting energy to the web. In general, a vibrational frequency of 1,000 to 2,000 cycles per minute supplies ample energy to an array of moistened textile fibers to cause the appearance of an apertured pattern in the process of this invention. The construction of the paddle, as shown in FIGURES 1, 6, 7 and 8, will be discussed in more detail below.

The apertured fibrous array **1** is conveyed by conventional means such as the screen or belt **12** driven by rolls **10** to a drying apparatus (not shown) if the array contains a binder at this point, or if binder application has been delayed to this point and a binder is desired, it may be applied by a spray mechanism such as indicated at **13**. For economy in binder application and in drying requirements, it is generally desirable to pass the fibrous array, wet with 800% to 1500% of water, over the conventional suction box **16**, before applying a binder, to dewater the web substantially before binder application and drying steps are carried out. Alternative methods of applying a binder, such as by a transfer roll, or by immersion in binder solution, or by blowing or dusting on binder in powdered form, may obviously be used. Similarly, the use of a multiplicity of binders, or of binders and catalysts or activating agents therefor, as commonly known and practiced in the non-woven art, will be obvious to those skilled in the art, and are cited as known alternatives to the binding process. If the basic array of fibers is a mixture of activatable and passive fibers, such as thermoplastic and thermostable fibers, subsequent activation of the activatable fibers, as by heat, may be used to bond the array together.

In the formation of apertures by the apparatus of this invention, advantage is taken of the fact that fibers which are wet with 800–1500% of water, as is preferred in the present process, are generally discretely separated from each other by fluid, and are not so frictionally interassociated, nor so circumscribed in their responses to the influence of externally applied forces, as they were in the dry assembled state. It is believed that the rapid application of the pulsating impact force to the barrier film lying on top of the fibrous array creates a series of shock waves in the fluid layer transporting the fibers, and it appears to be the cumulative effect of these repeated impulses that moves the fibers, by successive stages, from the higher points of greatest impact into the grooves of the forming roll.

An unexpected advantage derived from the process of this invention lies in the discovery that in the yarn-like arrays developed by this process, the fibers in the yarn-like array, though apparently parallelized, show on closer examination that at numerous points throughout their length they are wrapped around the yarn-like bundle, and are integrated-in-depth therewith. Individual fibers in the yarn-like bundles pursue an irregular path. Although predominantly arranged in the general directions governed by the grooves in the forming rolls, the fibers wrap around each other, and fibers or groups of fibers appear now on one side, now on the other side, of the yarn-like structure of which they are the components. This is illustrated in FIGURE 11, which is a highly enlarged drawing of a few fibers formed into a representative aperture. It should be understood that a typical pseudo-yarn of this invention contains several scores of fibers in each bundle, a very few fibers being shown here for the sake of clarity.

This interlacing of the fibers into a pseudo-twisted yarn-like structure seems to be characteristic of the behavior of textile-length fibers in the process of this invention, and is not found when the fibrous array is made up entirely of fibers of paper-making length. Paper-making fibers or short fibers in general of less than ¼ inch in length do not have sufficient length, used alone, to wrap around the yarn-like structures formed by this process. In general, they yield structures that are quite lacking in strength unless heavily bonded.

Although a certain percentage of shorter or paper-making fibers may be mixed with textile-length fibers in the process of this invention, it is preferred that at least half of the fibers shall be of textile-length; that is, capable of being formed into webs or fleeces by the dry assembling processes used in the textile art, such as cards, garnetts, Rando-Webbers, and the like. Apart from length, any fibers suitable for dry assembling, such as cotton, rayon, acetate, nylon, etc., are amendable in varying degrees to the preparation of apertured non-woven fabrics by the process of this invention.

The orientation of the fibers in the fibrous array, as presented to the forming roll for impaction into an apertured form, is a very important factor in determining how the fibers shall eventually be distributed, in population, between pseudo "wrap" yarns and pseudo "filling" yarns. Obviously, if all fibers were perfectly parallelized in the machine direction, the fibers would be impacted only into the circumferential grooves in the forming roll, which may be called for convenience the east-west grooves. The resulting array would be a set of internally integrated but twistless pseudo-yarns, resembling the warp of a fabric, with substantially no filling component. By the application of a binding medium, such twistless yarns can be given enough strength to allow their subsequent processing into woven fabrics of superior softness and appeal.

The fleece drawn from a cotton card is characterized by having its fibers predominantly, although not entirely, oriented in the machine direction. Therefore, unless special precautions are taken, the formation of a square patterned apertured non-woven fabric is characterized by the emergence of "warp" yarns which are somewhat stronger than the "filling" yarns. However, a fiber does not have to be oriented in the cross, or north-south direction, to become a component of a filling yarn. Textile fibers in a fleece, due to their softness and flexibility, commonly have components along their length which are oriented at substantial angles to the main overall orientation of the fiber. The result of repeated subaqueous impact on fibers with parts of their length posed at varying angles to the main axis of fiber travel is that parts of the fibers are aligned in the east-west grooves and parts in the north-south grooves, so that a single fiber may be part of the yarn associated with more than one aperture, and may be aligned with the warp or filling or both.

It is a frequent practice in the textile art to cross-lay fibers by means of a "camel-back" arrangement, whereby one or more webs or card fleeces are laid on a conveyor belt in layers which are at a substantial and controlled angle to each other. When such fibrous arrays are used in the process of this invention, with layers of fibers running northeast-southwest and northwest-southeast, a diamond-patterned forming roll may be advantageously used, as shown in FIGURE 12, to develop a product illustrated in FIGURE 13. By cross-laying fibrous arrays at various angles, and by arranging the grooves in the forming roll at corresponding angles, products can be made which simulate netted, laced, or knitted fabrics, as well as woven fabrics. It will be apparent that a process of this sort is not limited to the formation of plain, regularly-arranged geometric designs, but that many fancy or ornate non-woven fabrics may be made which would be impossible or prohibitively expensive to reproduce from yarns by weaving.

As an alternative arrangement for the process of this invention, it is entirely feasible to divide the pattern of yarn-like arrays so that part of the design is imparted by the forming roll and part by the impacting device. Such a division of pattern is shown in detail in FIGURES 4 and 7, representing respectively a transversely grooved forming roll and an impacting paddle grooved in the machine direction, or direction of fiber travel. When such a pair of devices is used in the process of FIGURE 1, the regrouped fibers are concentrated in the grooved areas **20** of the impacting paddle **8** of FIGURE 7, and this pattern of pseudo-yarns, advancing in the machine direction, will be intercepted at intervals by pseudo-filling yarns spaced as dictated mechanically by the spacing between transverse grooves **21** of the forming roll of FIGURE 4.

It is likewise possible to reverse the distribution of the pattern elements so that the forming roll **9** of FIGURE 1 is provided with circumferential grooves and the impaction paddle **8** with transverse grooves, running across the direction of the fiber travel. In this case, however, the question of phasing or register of lines becomes very critical. The production of a clear-cut pattern of apertures seems to be a question of the cumulative effect of incremented repetition, each stroke of the impacting device adding some rearranging force to the forces of the strokes that have gone before. If the grooves in the impacting device are transverse, as in the modification under discussion, it is important that the rate of traverse of

the wet fibrous array through the process shall be geared closely to the rate of vibration of the paddle, so that each transverse groove shall fall into the path of the groove that went before it on the preceding stroke. If this phasing and register are not regulated, the result is a product as shown in FIGURE 14, an array of pseudo-warp yarns **27** attached to each other by a generally attenuated series of fibrous bands **28**, said bands not being grouped into definite yarn-like aggregates.

Although the impacting device in preferred form has been shown as an oscillating paddle driven from a shaft, it will be obvious to those skilled in the art that alternative devices are possible. One alternative is shown in FIGURE 10, where the impacting blade **8** is fixed to a suitable resilient flexible member **22**, such as a sheet of spring steel, which is anchored at one end by the clamp support **23**. The flexible member **22** is alternately raised and allowed to drop back by contact with the teeth **25** of multi-lobed cam roll **24**, rotating on the shaft **26**. Such an arrangement is similar in principle to the working of a "watchman's rattle."

Satisfactory results are also obtained from the use of a series of paddles fixed into a rotating shaft, so mounted as to give a repeated series of blows to the wet web as it is supported on the forming roll. Such an arrangement is shown in FIGURE 15, wherein the web **1**, supported on the rotating forming roll **9**, is subjected to repeated blows from the resilient paddles **30**, **31**, **32**, **33**, affixed to the rotating shaft **34**. In the use of a rotating multi-bladed device such as shown in FIGURE 15, the shaft **34** rotates at a speed such that at least one complete revolution is made for each traverse of one inch of web around the periphery of the forming roll. As a minimum, therefore, if the web is being apertured at a rate of 10 yards per minute, the shaft **34** should rotate at 360 revolutions per minute. Preferably the shaft **34** should rotate at speeds substantially in excess of this minimum, so that a multiplicity of impacts is delivered to each linear segment of web traversing the circumference of the forming roll. In general, however, it has been found that a rotating impactor of this sort, though suitable for coarse work, does not give as clear a definition of apertures as the preferred reciprocating impactor. It has also been generally found that the use of the protective membrane **6** of FIGURE 15 is highly desirable when a rotating multi-bladed arrangement is used, since rotary motion involves some slippage or wiping action of the impacting blades along the body of the web.

In addition to dividing the function of yarn-like array formation so that one set of arrays is formed on the surface of the forming roll and an intersecting set is formed by the grooved design on the impacting blade, it is also feasible to design the surface of the protective membrane **6**, of FIGURES 1 and 15, so that it imparts a distinctive pattern to the rearranged fibrous web. Thus a transversely grooved forming roll, such as shown in FIGURE 4, may have superimposed thereon a suitably premoistened fibrous web. If the protective film **6**, intervening between the web and the impacting device, is provided with a pattern of ribs or raised lands running continuously in the machine or long direction of the film the use of a plain-surfaced impacting blade will cause the pattern of ribs on the film or plastic belt to coact with the grooves in the forming roll. In the cited case where the forming roll grooves are transversely oriented and the ribs on the belt are oriented in the machine direction, the result will be a non-woven fabric with rectilinear apertures of a size governed by the relative spacings of the grooves of the forming roll and the raised ribs of the belt.

It is also within the scope of this invention to rely upon the patterned surface of the forming roll, or of the impacting blade, or both conjointly, to impart a principal bold pattern of apertures to a fibrous web, which pattern may be elaborated by a secondary set of lands and grooves supplied by a contoured surface on the protective membrane. Various delicate and intricate designs may be effected by thus dividing the aperture-forming function between the elements used.

Although the lands and grooves discussed hitherto have been illustrated as being angularly disposed to each other, it is of course quite feasible to devise a forming roll where the lands are in the form of islands of circular, oval, or even irregular cross-section, or where certain lands are raised. That is, it is possible in a pattern of circular lands to have every alternate land in a row project slightly further from the surface of the forming roll than the lands immediately adjacent. This results in a novel pattern of alternately clear-cut and slightly filmed-over circular apertures since the raised lands absorb more energy from the impacting device and thereby more forcibly rearrange the fibers lying thereon.

In all modifications of impacting devices cited herein, it has been found that the impacting blade or head is a critical element in the proper practice of this invention. It is preferred that the blade be of a resilient material such as rubber. For best results, a highly-filled or "dead" rubber appears preferable, such rubber stocks being characterized as having a coefficient of restitution of around 0.40 to 0.60. Livelier rubber stocks, with a coefficient of restitution of over 0.70, generally give poorer aperture definition and more web distortion. The coefficient of restitution of a rubber is a recognized measure of its bounce, or liveliness. It may be presumed that in carrying out this invention, there is a partition of energy at the instant the paddle strikes the web. Part of the energy is absorbed by the rearrangement of the fibers in the web, and part absorbed by the paddle in a rebound motion. It may also be that a certain minute dwell time aids in the formation of clearly defined apertures, so that very elastic stocks rebound too rapidly to be effective. Whatever the reason, it has been found, as stated above, that rubber of a coefficient of restitution of 0.40 to 0.60 is preferred in the practice of this invention.

Teflon, a tetrafluoroethylene polymer made by the duPont Company, and other elastomeric plastic stocks can be used for the impacting blade of this invention, provided their combined properties meet the characteristics of the rubber blade as set forth above. Teflon has a particular non-wetting property, so that on impact it does not adhere to the wet web and cause distortion even when no intervening barrier film (6, FIGURE 1) is used. A particularly advantageous combination is a rubber blade, with the long flex-life of rubber, surfaced with a layer of Teflon on the impacting face. Other elastomeric combinations will be apparent to those skilled in the art.

The following specific example will serve to illustrate the method and apparatus of this invention in the preparation of an apertured non-woven fabric.

Example

Using conventional carding equipment, a web was formed of 100% viscose fibers of 1.5 denier, 1$\frac{9}{16}$ inches long, weighing 15 grams per square yard. By means of the apparatus shown in FIGURE 1, this web was thoroughly saturated with water by means of the flooder box **2**, after which the suction box **5** was used to reduce the moisture content to approximately 1,000%. By means of the screen **4**, the wet web was continuously fed to the patterned roll **9**.

In this example the pattern formation was provided by the joint interaction of the impact blade **8** and the forming roll **9** as shown in FIGURES 4 and 7. The grooves in the impact blade were parallel to the machine or processing direction, and were $\frac{1}{16}$ inch deep and 0.130 inch apart, in a blade ½ inch thick and 4 inches wide. The blade, oscillated by means of a conventional textile vibratory "comb box" **35** attached to the shaft **11**, was adjusted to strike the wet web at within plus or minus 30° of the apex or uppermost point on the circumference of the forming roll. That is, if the uppermost point on

the circumference of the forming roll is regarded as at 12 o'clock, no significant difference in performance of the process is noted as the point of contact of the impacting blade with said circumference is varied between 11 o'clock and 1 o'clock.

The coefficient of restitution of the rubber stock was 0.41.

The transverse, or "filling" pseudo-yarns were formed by the forming roll, a metal roll 2 inches in diameter provided with axially-cut grooves which were 0.40 inch wide and 0.060 inch deep.

The impact blade, driven by the comb box, was caused to vibrate at a frequency of 1100 cycles per minute while the web was processed at a speed of 10 yards per minute.

After aperturing, the web was continuously stripped from the forming roll, dewatered, and bonded by the spray application of 10% of a binder in fluid form. The product weighed approximately 16.5 grams per square yard and possessed many of the attributes of a sample of coarse gauze, 7 x 6 count, woven from thick yarns.

Having thus described my invention, what I claim is:

1. An apparatus for preparing an apertured non-woven fabric comprising a moving surface of interspaced lands and grooves oriented transversely to the direction of motion of said moving surface, means for delivering a moistened web to said surface, means for imparting repeated mechanical impacts to the moist web while said web is on the moving surface of interspaced transverse lands and grooves, said impacting means having a surface grooved parallel to the direction of motion of said moving surface, and means for removing the resulting apertured web from said surface.

2. An apparatus for preparing an apertured non-woven fabric comprising a moving surface of interspaced lands and grooves oriented parallel to the direction of motion of said moving surface, means for delivering a moistened web to said surface, means for imparting repeated mechanical impacts to the moist web while said web is on the moving surface of interspaced parallel lands and grooves, said impacting means having a surface grooved transversely to the direction of motion of said moving surface, and means for removing the resulting apertured web from said surface.

3. A process for preparing a flexible sheet of apertured non-woven fabric which comprises saturating a fleece of unspun textile-length fibers with a liquid lubricant therefor, continuously conveying said saturated fleece over a patterned surface of lands and interconnected grooves, said patterned surface moving with said fleece, subjecting said fleece to repeated mechanical vibratory impacts from a solid, plain-surfaced resilient elastic paddle, said impacts being substantially normal to the direction of traverse of said saturated fleece causing the fibers of said fleece to aggregate into the interconnecting grooves of said patterned surface, and removing the resulting apertured non-woven fabric from said patterned surface.

4. The process according to claim 3 wherein the patterned surface of lands and interconnected grooves forms the surface of a cylindrical roll.

5. The process according to claim 3 wherein the lands and grooves of the patterned surface are non-rectilinear in orientation.

6. A process for preparing a flexible sheet of apertured non-woven fabric which comprises saturating a fleece of intermingled unspun textile-length thermoplastic and non-thermoplastic fibers with a liquid lubricant for at least one of said types of fibers, continuously conveying said saturated fleece over a patterned surface of lands and interconnected grooves, said patterned surface moving with said fleece, subjecting said fleece to repeated mechanical vibratory impacts from a solid plain-surfaces resilient elastic paddle, said impacts being substantially normal to the direction of traverse of said saturated fleece causing the fibers of said fleece to aggregate into the interconnect-

ing grooves of said patterned surface, and thermally activating at least some of said thermoplastic fibers to bond said activated fibers to each other and to at least some of the non-thermoplastic fibers of said non-woven fabric.

7. A process for preparing a flexible sheet of apertured non-woven fabric which comprises saturating a fleece of unspun textile-length fibers with a liquid lubricant therefor, continuously conveying said saturated fleece over a moving surface bearing a pattern of grooves oriented substantially transversely to the main axis of said saturated fleece, subjecting said fleece to repeated mechanical vibratory impacts from a vibrating resilient member surfaced with a pattern of grooves oriented substantially parallel to the main axis of said fleece, said impacts being delivered substantially normal to the plane of said fleece, and continuously removing the resulting apertured non-woven fabric from said patterned surface.

8. An apparatus for preparing an apertured non-woven fabric which comprises a moving patterned surface of lands and interconnected grooves, means for conveying

a moistened fleece of textile-length fibers continuously across said patterned surface and in registration therewith, means comprising a solid resilient paddle for imparting to said moving fleece a series of repeated mechanical vibratory impacts substantially normal to the plane of said fleece while said fleece is on said moving patterned surface, and means for continuously removing the resulting apertured fleece from said surface.

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