United States Patent [19]

Allen

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[54] **PROCESS FOR RANDOMIZING CARD WEBS**

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[73] Assignee: **The Kendall Company,** Walpole, Mass.

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[52] **U.S. Cl.** ..... **19/106 R,** 19/156

[51] **Int. Cl.** **D01g 15/46**

[58] **Field of Search**..... 19/156, 156.3, 156.4, 106 R

[56] **References Cited**

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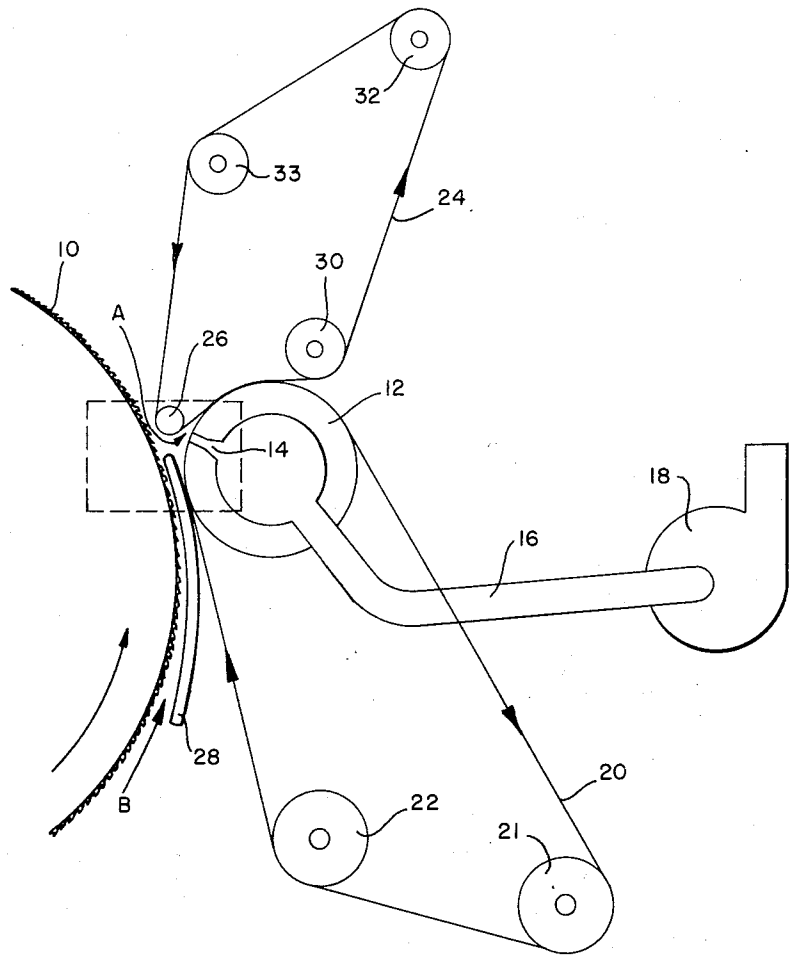
Primary Examiner—Dorsey Newton

Attorney, Agent, or Firm—John F. Ryan

[57] **ABSTRACT**

The generally parallelized orientation of fibers being removed from the doffer of a card is randomized by withdrawing the web of fibers by means of a pair of conveyor belts and a vacuum slot situated adjacent to the rotating doffer surface.

2 Claims, 3 Drawing Figures



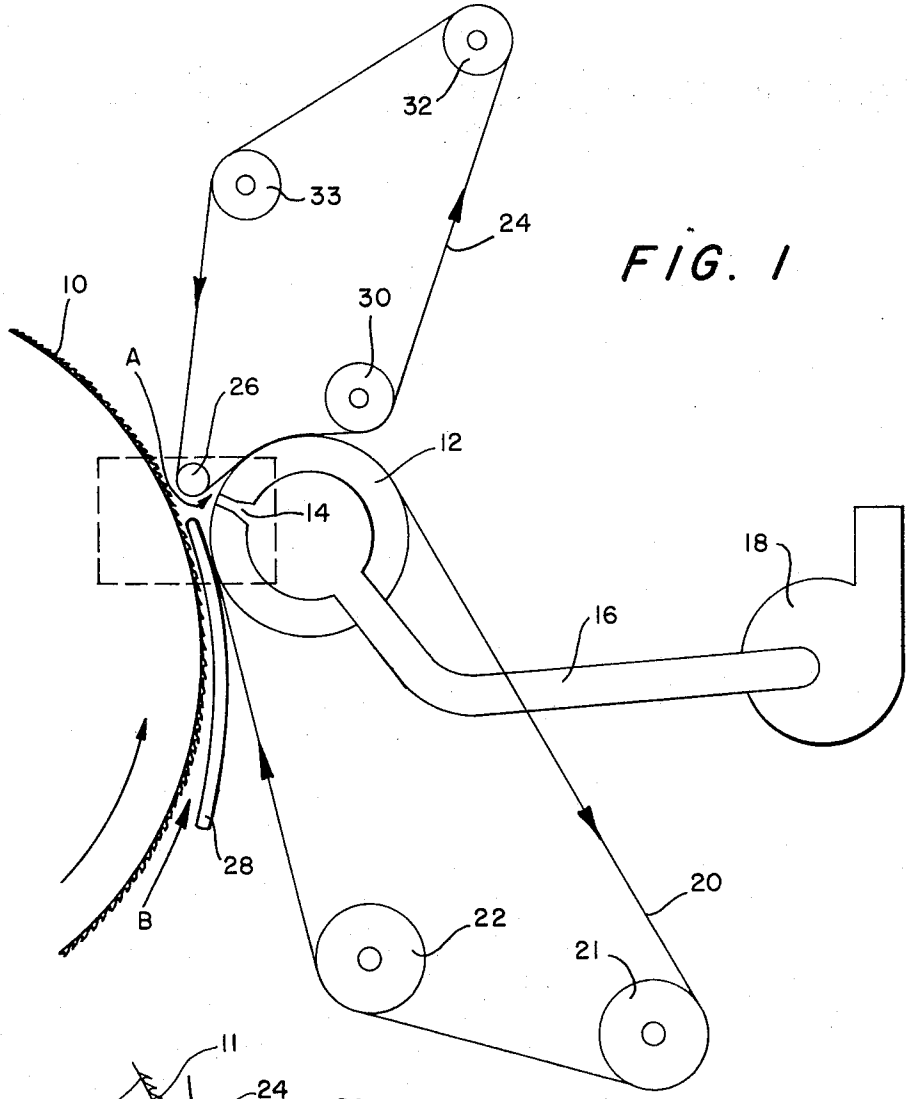

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A
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FIG. 1

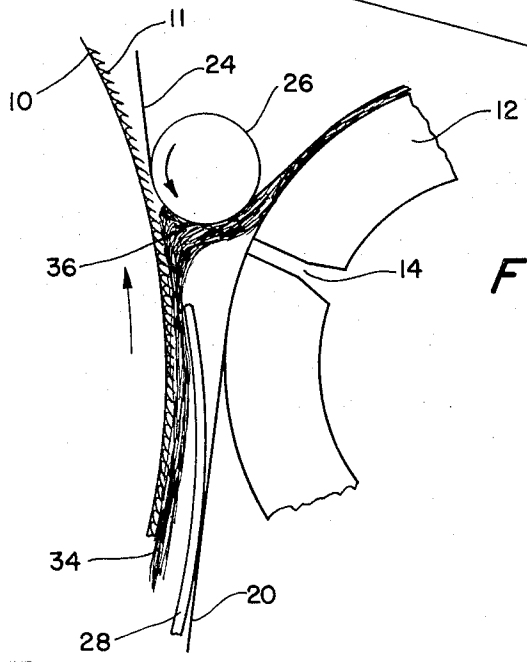

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FIG. 2

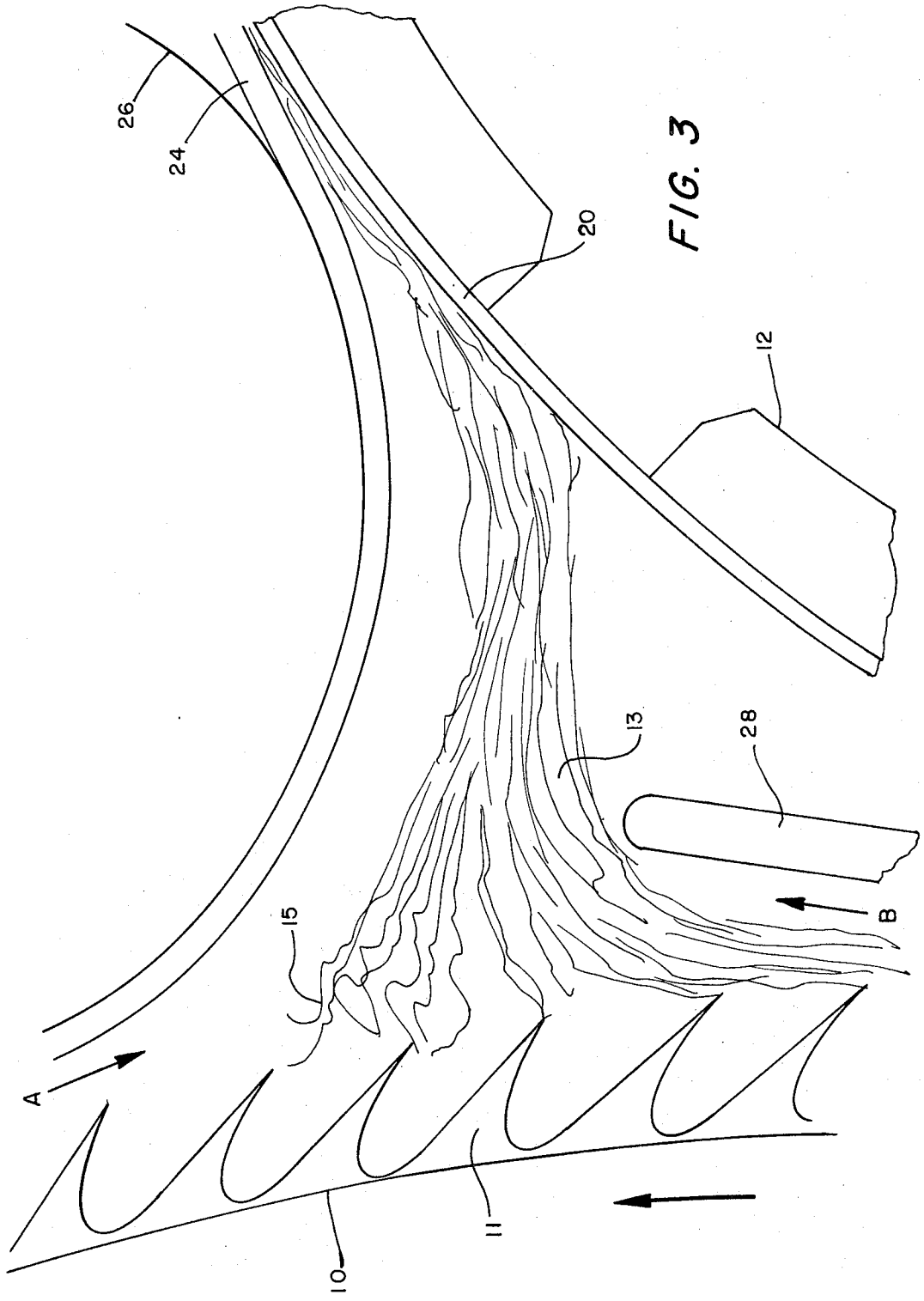


FIG. 3

PROCESS FOR RANDOMIZING CARD WEBS

This invention relates to a process for improving the ratio of longitudinal strength to lateral strength in carded webs of textile-length fibers. Particularly, it relates to a method for more nearly equalizing the longitudinal and lateral strengths in bonded nonwoven fabrics prepared from such webs.

In the preparation of nonwoven fabrics, it is common practice to feed a thick lap or sheet of textile length fibers, weighing up to 500 grams per square yard, to a fiber-rearranging device such as a card, garnett, or airlay device, which forms the fibers into a thin web or fleece with a weight attenuation of about 100 to 1. Among web-forming devices, the card is perhaps the most commonly used.

A conventional textile card comprises a cylinder, 3 to 4 feet in diameter and of any desired width, covered with a multiplicity of teeth called card clothing. A lap of fibers is fed by means of a so called licker-in roll to this main cylinder, which picks up and carries fiber clumps partway around its circumference. Around this main cylinder are located auxiliary rolls or flat strips covered with wire teeth set in close proximity to the circumference of the main cylinder, and serving to comb and open the clumps. The fibers are removed from the cylinder by a doffing device, conventionally a secondary tooth-covered cylinder tangential to the main cylinder and revolving in the opposite direction. Fibers are in turn removed from the doffer by various conventional combinations of small rolls or by a reciprocating comb.

The conventional textile card or carding machine was primarily devised to exert a two-fold effect. First, it cleaned an array of fibers such as cotton or wool, removing considerable dirt, other foreign matter, and short fibers. Second, it tended to parallelize and rearrange the fibers, which was a desirable consequence since the fibrous web was customarily drafted and spun into yarn in a multi-stage process. With the advent of the nonwoven fabric industry, however, many cards were converted from their original function of preparing a sliver of parallelized fibers to delivering a plurality of full-width webs to a conveyor belt, for subsequent bonding to form a nonwoven sheet. One of the advantages of carding, parallelization of fibers, become a distinct disadvantage in the preparation of some types of nonwoven fabrics. Spun yarns are expected to have strength only in the lengthwise direction, whereas the majority of nonwoven fabrics should have at least some minimal tensile strength in the transverse or cross-web direction. The problem is particularly acute in the case of nonwoven fabrics prepared from man-made fibers, which, although they may be crimped, are geneallly straighter and much more readily and completely oriented by carding than natural fibers such as cotton.

A further complication is that the conventional processing of bonded nonwoven fabrics consists of a set of stages — conveying, saturating, drying, winding, etc., — all of which impose a further drafting and parallelizing effect on the fibrous web. If a web is carefully removed from the doffer of a card and is bonded without drafting or distortion, the longitudinal (machine direction) tensile strength may be only 3 or 4 times the lateral (cross direction) tensile strength. If the same web is subjected to a "normal" multi-stage bonding operation, tensile strength ratios will be found which are 10 to 20 to 1, machine direction to cross direction.

Various expedients are resorted to for improving what will hereinafter be referred to simply as the strength ratio, it being understood that this refers to the ratio of strength in the machine or longitudinal direction to the cross or lateral direction. One expedient is to disperse the fibers in more or less random orientation into an air stream, from which they are collected on a perforated rotating drum by suction. Such devices are expensive, and while satisfactory at speeds of around 10 yards per minute, they produce webs of poorer quality at speeds of over 15 yards per minute, due to clumping and poor dispersion of fibers.

Another common method of improving the strength ratio is by means of a cross-laying device, whereby a full-width web of oriented fibers is mechanically pleated back and forth across a conveyor belt to build up a composite batt in which the average angular displacement of the fibers is alternated. Such devices again are slow, cumbersome, and are suitable only for batts of substantial thickness where fold marks and overlap ridges are not objectionable.

It is with improvements in the art of producing fibrous webs and bonded nonwoven fabrics of more nearly equalized machine direction and cross direction tensile strengths that the present invention is concerned. It is a primary object of the invention to provide a process and a device which will rearrange an array of substantially parallelized textile-length fibers to produce an array in which the ratio of machine-direction strength to cross-direction strength is closer to unity.

Basically, the process of this invention comprises a vacuum doffing device which removes the fibrous web carried by the doffer at a linear speed which preferably is not more than 83 percent, and may be as low as 50 percent, of the surface speed of the doffer. Expressed otherwise, the cylindrical doffer adjacent to the main cylinder of the card travels at a surface speed which is 1.2 to 2.0 times the linear speed at which the fibrous web is removed from the doffer.

As explained in more detail below, the vacuum doffing device not only draws the fibrous web from the revolving doffer, but tends to create an onrush of air from various directions into the doffing zone. The onrush of air, however, is substantially confined to a single air stream drawn downward into the doffer zone by a pair of baffle devices, one being a curved shield and the other a moving conveyor.

In this manner, a turbulent zone is established between the doffer and the take-off mechanism, wherein the fibrous web abruptly changes direction and a sort of scrambling or mixing operation takes place, due presumably to the action of the air stream on the trailing ends of the fibers floating between the doffer surface and the vacuum device. As a result, the normally linear fiber profile is distorted, and webs produced therefrom have a more nearly equalized machine direction to cross-direction strength.

The invention will be better understood with reference to the following description and drawings, in which:

FIG. 1 is a schematic front elevation of an apparatus suitable for carrying out the process of this invention;

FIG. 2 is a similar but enlarged representation of the area of FIG. 1 enclosed in dotted lines, showing the be-

havior of a carded web in the process of this invention;

FIG. 3 is a still more highly enlarged representation of the doffing zone of FIG. 2.

Referring to FIG. 1, there is shown a card doffer, 10, which functions to receive a card web from a card cylinder. The doffer is conventional, and its function as well as all the preceding functions of web formation may be considered as conventional.

Instead of a reciprocating or rotating comb, the web-transfer mechanism comprises a suction box, mating conveyor belts, associated drive and guide rolls, and air shielding and guiding means, as explained more fully below. The various elements are positionally located with respect to each other and to the doffer as to provide a web-transferring and reorientation zone. The suction box 12, which is conveniently in the form of a hollow cylindrical roll extending across the full width of the doffer face, is slotted as shown at 14, and connected by the ducting 16 to a blower 18 or other conventional device for establishing and maintaining a uniform vacuum inside the vacuum box 12.

A fine-mesh screen 20 of about 60 threads per inch serves as a conveyor belt for the rearranged fibrous web, said screen being driven by drive roll 21 and passing around the guide roll 22, from whence it slides around the stationary vacuum box 12.

In order to reduce air currents coming toward the slot from the direction of the fiber feed, a rigid curved shield, 28, running the full width of the doffer, is spaced at a distance of 1/16 to 1/8 inch from the doffer. The conveyor screen 20, in its traverse from the guide roll 22 to the suction box 12, makes touching contact with the shield 28, which reduces air currents from this source.

In order to block extraneous air from coming to the zone between the discharge area of the web and conveyor, apart from the main air stream A of FIG. 3, a mating nip conveyor 24, preferably air-impervious, is provided, which helps to carry the web from the suction slot where it is being formed. The secondary conveyor may be driven by the drive roll 30, passing around the roll 32 to guider roll 33, and thence around the small roll 26, which like the shield 28 is mounted at a spacing of 1/16 to 1/8 inch from the doffer surface. The speeds of the two conveyor belts 20 and 24 are maintained substantially equal, to prevent distortion and pilling of the web.

For optimum operation, the spatial arrangement of the three critical components — the roll 26, vacuum slot 14, and shield 28 — is preferably made adjustable in order to be able to process fibers varying widely in denier, staple length, rigidity, and web weight. For this purpose, the vacuum box 12 may be rotated on its axis to change the angle at which the vacuum slot 14 is presented to the doffer. The roll 26 is laterally adjustable, to open or close the nip made by the two conveyors 20 and 24. Similarly, the shield 28 is mounted to be adjustable in an upward or downward direction.

Still referring to FIG. 2, a normally oriented fibrous web 34 is shown as carried on the teeth 11 of the doffer surface under the shield 28. At the juxtaposition of roll 26, vacuum slot 14, and the upper edge of the guide plate 28, there exists a zone where air is being drawn into the vacuum slot at a rate of between 6 and 18 cubic feet per minute per inch of slot width, mainly from the gap generated between the doffer and the roll 26.

Referring to FIG. 3, in which only a few fibers are shown for the sake of clarity, individual fibers 13 are shown as being carried by the teeth 11 of the doffer 10 with a leading end, as in normal carding. Air (B in FIG. 3) coming up between the shield 28 and the doffer surface is of minor effect, and is not considered to effect the orientation of the fibers on the teeth except to help the fibers to maintain their leading end orientation. This secondary air stream B is necessarily low in its effect due to the close proximity of the shield 28 to the tips of the teeth on the doffer surface.

At a certain point, the angle of the backwardly raked doffer teeth becomes such that the sections of the fibers 13 held by a tooth are released and impelled toward the vacuum slot by the principal air stream A passing downwardly between the roll 26 and the doffer surface. In this manner, the trailing section of the fiber is suddenly released to follow the leading section of the fiber, already stressed toward the vacuum slot. The result of this sudden release is a twisting or buckling of the trailing section of the fiber, in its path toward the slot, whereby the fiber is reoriented from a generally parallelized to a more random and cursive array, as shown by the fibers 15.

In order to allow this buckling action, responsible for fiber reorientation, it has been found that the linear surface speed of the doffer 10 should be at least 1.2 times the linear speed of the conveyor screen 20, as mentioned above. Also, it has been found that when the fiber length is that length normally used in the production of nonwoven fabrics — that is, at least 1.25 inches — the shortest path from the doffer 10 to the vacuum slot 14 is substantially less than the average fiber length. A satisfactory working distance from doffer surface to vacuum slot is 0.75 inches when fibers of about 1.5 inches in length are being processed.

If the conveyor screen carrying the web is traveling at a speed equal to or greater than the linear surface speed of the doffer, the fibers in the process of forming the web will be kept generally as parallelized as they were on the doffer surface, and no reorientation will occur. A 20 percent overfeed between doffer and conveyor screen, however, results in a slack condition in the trailing section of the fibers, with a consequent buckling, twisting, and reorientation.

THe invention will be illustrated by the following table. In each pair of cases, A and B, C and D, a plain carded web was compared with a card web randomized by the process of this invention, the physical constants being measured after all webs were bonded with the same acrylic bonding agent, dried, conditioned, and tested under controlled parallel conditions. All webs were processed from the same lot of 1 9/16 inch viscose rayon.

	Web A Plain	Web B Random	Web C Plain	Web D Random
Fabric Weight	46.3	50.3	25.6	22.0
Fiber Weight	33.0	38.5	16.5	19.0
Binder Weight	13.3	11.8	9.1	3.0
Tensile, M.D.	11.2	9.7	6.6	4.3
Tensile C.D.	1.6	5.4	1.0	2.1
Ratio of Tensiles	7:1	1.8:1	6.6:1	2:1
Tear M.D.	0.95	1.0	0.58	0.51
Tear C.D.	1.50	2.0	0.70	0.87

Weights are expressed in grams per square yard, tensiles (MD and CD referring to machine direction and cross direction respectively) in pounds per inch-wide strip, measured on an Instron.

It is thus seen that in each case a machine direction-cross direction strength ratio has dropped from 6.6 or 7 to 1 to 1.8 or 2.0 to 1, and that this equalization, due to randomization of the fibers, has been effected without a deleterious over-all decrease in the tensile properties of the fabric.

Having thus described my invention, I claim:

1. A process for rearranging the orientation of fibers in a web which comprises:

carrying a web of fibers on a moving cylindrical surface having a multiplicity of teeth,

retaining said web on said surface until it reaches a doffing zone,

withdrawing air by a vacuum slot from said doffing zone through a moving air-permeable conveyor positioned less than an average fiber length from said moving surface,

creating an onrush of air from various directions and guiding said air into a stream from above said doffing zone to impinge upon said web while said web is in said doffing zone, thereby creating a turbulent zone therein that causes said web to abruptly change direction and causes at least the trailing ends of a substantial number of fibers of said web to become bent, buckled, and distorted into random arrangement,

withdrawing said air stream through said vacuum slot while substantially blocking air from entering said doffing zone from directions opposed to said air stream, said web being doffed from said moving surface in said doffing zone by the vacuum in said vacuum slot,

and, depositing said randomized web on said moving air-permeable conveyor,

said conveyor moving at a linear speed which is at least 20 percent less than the linear speed of said moving cylindrical surface.

2. The process according to claim 1 wherein the linear speed of said air-permeable conveyor is between 50 percent and 83 percent of the linear surface speed of said moving cylindrical surface.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,787,930 Dated JANUARY 29, 1974

Inventor(s) GEORGE H. ALLEN

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Claim 2, line 2, change "83%", to -- 80% --

Signed and sealed this 3rd day of Septembr 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.