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[54] METHOD OF CONTINUOUSLY MAKING A UNIFORM NONWOVEN FABRIC

6 Claims, 1 Drawing Fig.

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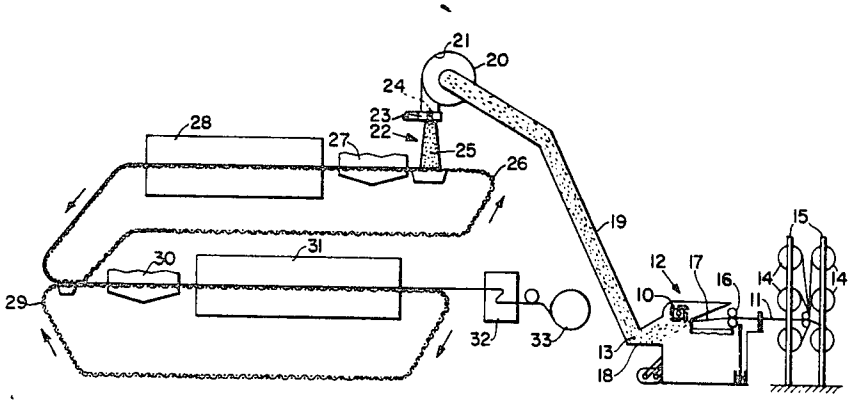
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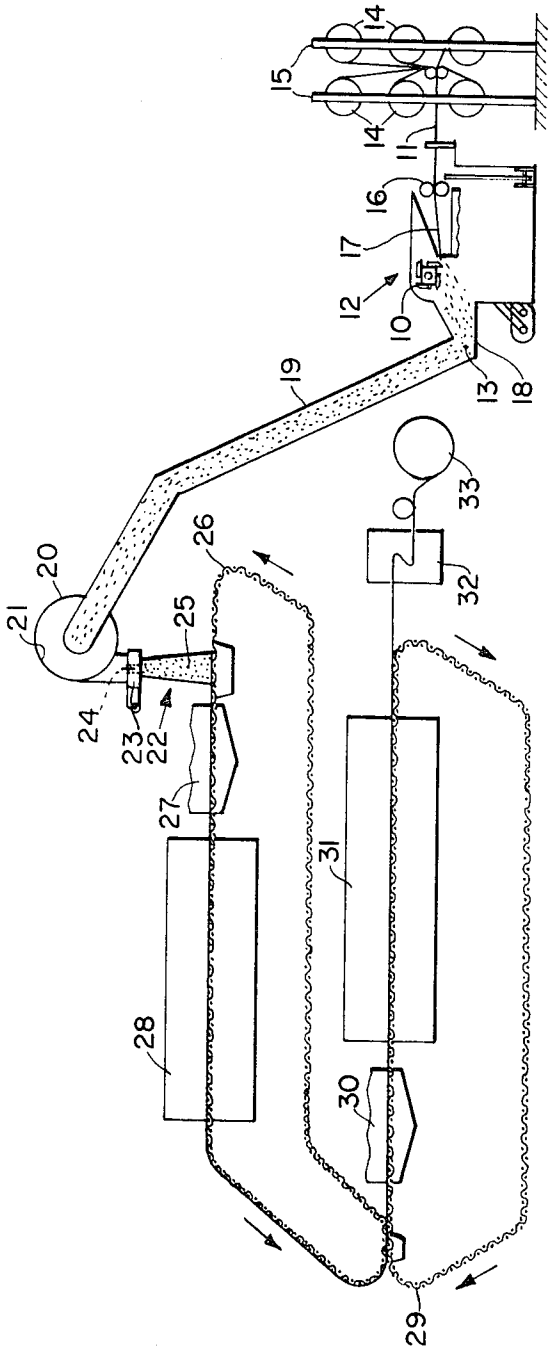
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ABSTRACT: A method of making nonwoven fabrics from one or more strands of rayon tow wherein at least one strand is continuously fed to a cutter which severs the strand into short bundles, preferably from about 0.2 to about 0.4 inch in length. The bundles of fibers are partially separated and dispersed as they are moved to an enclosed chamber by a blower. An air knife directs air jets transversely to the direction of fiber flow in the enclosed chamber in order to completely separate the individual fibers whereupon they are uniformly deposited in random fashion on a wire. The nonwoven fabric is completed by the conventional steps of spraying a binder composition on the fibers followed by drying.



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METHOD OF CONTINUOUSLY MAKING A UNIFORM NONWOVEN FABRIC

CROSS-REFERENCE TO RELATED APPLICATION

The present method is particularly suitable for use in the practice of a method such as that disclosed and claimed in the copending application Ser. No. 753,352, filed Aug. 19, 1968 by Ralph J. Baskerville, Jr. and Joseph S. Baker entitled PROCESS OF MAKING A NONWOVEN FABRIC. The latter application is assigned to and commonly owned by the assignee of the present application.

BACKGROUND OF THE INVENTION

It is generally well known that the procedure for making nonwoven fabrics usually includes the processing of fibers on special equipment of the kind commonly used in the manufacture of textiles. The fabrics made by such processes have many uses such as clothing material, packing material, construction material, etc. They are also used as top sheets in the manufacture of disposable diapers.

The most common and better nonwoven fabrics are generally produced by carding machinery capable of metering and spreading rayon staple supplied in bales into thin layers of evenly distributed fibers previous to bonding. In this method the fibers may be air transported between the liker-in roll of the carding machine and the fiber deposition wire. A variation of this method includes the step of scattering thinly accumulated layers of fibers in a pressurized air current. Still another method, called the "Rando Webber" method, combines the fiber scattering method and a hopper feeding method. These methods, however, invariably use fibers prepared in the form of raw staple as the starting material. The nature of the fibers which are used as a starting material limit the individual capacity of the method and equipment used. In particular, the carding machine has been one of the greatest limiting factors in the manufacturing of nonwoven fabrics in the form of continuous webs.

The fibers handled by equipment used in the above mentioned methods are relatively long and are difficult to deposit uniformly on the wire at substantial production rates. In addition, these methods produce webs at relatively slow speeds because of the need to interpose cumbersome machinery for suitably separating the individual fibers prior to laying them down to form the nonwoven sheet. Another undesirable feature of some of these prior methods is that they produce a nonwoven fabric product that is not uniformly strong in tension in all directions.

The present invention eliminates the aforestated drawbacks of the conventional processes and produces a more economical and superior nonwoven sheet at much higher production rates.

An object of the invention is to provide a process which eliminates the combing and fiber separating machinery and similar steps normally found in conventional methods of making nonwoven fabrics.

A further object of the invention is to provide a method of manufacturing webs which have uniform texture and relatively high strength in all directions.

Yet another object of the present invention is to provide a method of manufacturing nonwoven webs at substantially increased production speeds with a simultaneous increase in product quality.

SUMMARY OF THE INVENTION

The nature and substance of the invention can be briefly summarized as a process of making nonwoven fabrics from one or more strands of synthetic fiber tow, e.g., rayon, comprising the steps of feeding at least one strand of the rayon tow into a cutter at a substantially uniform rate. The tow strand is cut into relatively short lengths to form individual fiber bundles having a length of from about 0.1 to about 0.5 inch, preferably 0.2 inch to about 0.4 inch. The fiber bundles are dispersed into individual fibers in a zone of high air shear and turbulence whereupon they are deposited randomly and uniformly over the surface of a moving wire screen. The fibers deposited on the wire are ultimately sprayed by a suitable binder material and the sheet is continuously dried to produce a nonwoven fabric of uniform quality having substantially equal strength in all directions.

BRIEF DESCRIPTION OF THE DRAWING

The foregoing, as well as other objects and advantages of the present invention, will become apparent by reading the following detailed description in connection with the accompanying drawing. The single FIGURE of the drawing is a schematic illustration of apparatus suited for performing the several steps in practicing the method of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Throughout this description, reference will be made to the preferred practice of the invention in which fibers are cut from viscose rayon tow. It will be understood, however, that this material is used in the description primarily as an example since the invention can be carried out with any of the well-known fibers that are commonly used in the manufacture of nonwoven fabrics. By way of example, but not by way of limitation, such fibers might include other synthetic fibers including various forms of rayon such as cuprammonium rayon or other regenerated cellulosic fibers; cellulose esther fibers such as cellulose acetate and cellulose triacetate fibers; polymide fibers such as nylon 6, nylon 66, etc.; acrylic fibers, vinyl fibers, fluorocarbon fibers, dinitrile fibers and nitrile fibers.

It is also possible to practice the invention with any of the natural fibers in silver or tow form. Any of the fibers mentioned heretofore may be used either by itself or it can be blended in various proportions with any of the other fibers as desired, provided they are compatible in a desired blend.

The invention will be described in the context of cutting the fibers from a tow of rayon. It should be understood, however, that this is merely a preferred practice as the source of the fibers is immaterial to the practice of the process of this invention.

The principal utility of the invention lies in the formation at high production rates of nonwoven fabrics wherein the fibers are randomly disposed and are not predominantly oriented in any one direction. In general, however, the structure and arrangement of the fibers in the nonwoven fabric is not critical to the practice of the process of the present invention.

Referring now to the drawing, the process is initiated at the tow cutter **10** where continuous filaments or strands **11** are fed into the fiber cutting machine **12** at a rate such that the tow is cut into bundles **13** of uniform length. The tow cutter **10** is provided with continuously rotating cutting blades which produce a steady stream of short fibers in the form of fiber bundles **13** cut from the strand **11**. The tow strands **11** are fed continuously from one or more ball warps **14** supported by the strand **15**. Each of the strands **11** preferably is a single 200,000 denier tow strand in which the individual fibers have a denier of about 1.5.

A pair of feed rolls **16** engage the tow strands **11** and withdraw the strands **11** from the stand **15** whereupon the tow is fed to the cutting blades of the tow cutter **10**. As illustrated, the stand **15** supports six ball warps **14**. This makes it possible to feed anywhere from one to six strands **11** at a given time, depending on the nature of the nonwoven fabric sheet being manufactured. The feed rolls **16** are separated somewhat from the cutter **10** but the tow nevertheless takes the straightest path from the feed rolls **16** to the cutting edge by being sucked through a constricting rectangular duct **17** directly communicating with the tow cutter plenum **18**. The fiber length is determined by the ratio of the feed speed of the tow to the cutting rate, i.e., the length of tow fed per cut. In the present method, the length of fibers cut from the tow is controlled to be within the range of from about 0.1 to about 0.5 inch in

length. Preferably the length is held in the range of from about 0.2 to about 0.4 inch. Extremely good results have been obtained by maintaining the fiber length at about three-eighths of an inch. It has been found that fibers greater than 0.5 inch in length are difficult to deposit uniformly to obtain a sheet having substantially uniform characteristics. On the other hand, if the fibers are less than 0.1 inch in length, the finished sheet will be too weak in tension for any practical use.

After the tow strand **11** is cut into fiber bundles **13** of a desired length, the individual fibers are separated from the bundles **13** in the following steps. This is preferably initiated by air conveying the fiber bundles **13** through several separating devices. Preferably the bundles **13** of cut fibers are air conveyed through an elongated tube **19** into a centrifugal blower **20**. The centrifugal blower **20** has a rough peripheral inside surface **21** which is well suited for substantial separation of the individual fibers from the bundles. The centrifugal blower **20** is effective in separating a majority of the individual fibers in this fashion.

A further step of final separation is carried out in the chamber 22 beyond the blower 20. An air knife 23 is located in the chamber 22 for the purpose of separating any fibers that may still be clinging together after passing through the centrifugal blower 20. The air knife 23 consists of a single constricted slot 24 in the wall of the chamber 22. Air under pressure is injected by the air knife 23 into the fiber stream whereby the individual fibers 25 are dispersed throughout the entire chamber 22.

Several air knives can be used in the chamber **22**, if desired, although the air knife nearest the outlet to the blower **20** is by far the most efficient since it is operated in a zone of high fiber density. Downstream air knives operate with less efficiency since the fiber concentration in the lower zones is significantly reduced after the dispersion effect of the first knife. The chamber **22** carrying the dispersed fibers runs from the blower outlet down to the wire screen **26** where they are deposited for subsequent processing.

The individual separated fibers are randomly and uniformly deposited on the wire screen **26** whereupon they are formed into a nonwoven fabric sheet by subsequent steps which are conventional and well known in the art. The wire screen **26** continuously moves the fibers deposited thereon to a resin bonding zone or a spray station **27** equipped with single fluid spray nozzles centered above the wire screen **26** and pointing forward in the direction of wire motion at an angle of 35° with respect to the plane of the wire. The nozzles produce a flat spray jet of a suitable resin binder material. Preferably the binder can be any one or a combination of resins such as the (poly)acrylics or polymers of styrene/butadiene or polyvinyl resins in a water dispersion.

After the spraying of the resin binder, the wetted mat enters a hot air drying oven **28** wherein the resin solution is dried to bond the individual fibers together. The temperature in the drying oven normally averages about 240° F. while the air velocity through the sheet averages 1,200 feet per minute. If the drying oven is sufficiently long, the drying of the nonwoven fabric can be carried out at a wire speed of up to 1,000 feet per minute.

After bonding and drying the resin on the upper side, the mat is transferred to the lower wire screen **29** whereupon the lower side of the sheet is similarly processed to complete the nonwoven fabric. This is carried out at a spray station **30** and hot air drying oven **31**, the latter being similar in structure and operation to the spray station **27** and drying oven **28**, respectively.

The nonwoven fabric is completed by calendering the sheet through a calender stack **32** which contains a battery of three rolls. This flattens most of the surface irregularities and, more importantly, provides the fabric sheet with greater softness and pliability. The finished fabric is then rolled up on the reel **33**.

EXAMPLE I

An apparatus having a configuration substantially as illustrated in the drawing was operated continuously by feeding four strands of rayon tow into the cutter **10**. Each strand was of 200,000 total denier and consisted of 133,000 strands each of 1.5 denier. The cutter **10** was adjusted to cut the tow into individual fibers having a length of 0.260 inch at a tow feed rate of 1.32 pounds per minute. The cut fibers were conveyed to the dispersing device which consisted of a centrifugal blower **20** passing 14,000 c.f.m., operated at a speed of 2,050 r.p.m. whereby the fibers were randomly dispersed. Compressed air was delivered to the air knife **23** at a pressure of 60 pounds per square inch and at a rate of 100 c.f.m. The air was injected through the slot **24** transversely into the chamber **22** in order to assure complete separation of the individual fibers from the fiber bundles. The fibers were then deposited on the wire screen **26** over a width of 20.5 inches and moved forward to the spraying zone at a speed of 210 feet per minute. Acrylic resin binder solution was uniformly sprayed from nozzles at the spray station **27**. The binder was of the type identified as Rohm and Haas HA-8. The wetted mat then passed to the drying oven **28** wherein hot air at 240° F. was passed through the web at a velocity of 1,200 feet per minute causing the fibers to become bonded and form a self-supporting nonwoven web. The web was then transferred to the second wire screen **29** and moved forward to a second spray station **30** where it was uniformly sprayed from nozzles at the spray station **30** with an acrylic resin binder of the type identified as Rohm and Haas HA-12. This was followed by hot air drying in the oven **31** wherein hot air at 240° F. was passed through the web at a velocity of 1,200 feet per minute. The completed web was then calendered, removed from the process and rolled on a reel.

The finished web had 28 percent on a dry basis of binder solids 70 percent of which was applied at the spray station **27** with the remainder applied at the spray station **30**. The web made by this process had a basis weight of 29 grams per square meter. The fibers were thoroughly and uniformly dispersed and the finished sheet was uniform in texture and appearance. It had an average tensile strength in all directions of 1,400 grams per inch of width.

EXAMPLES II, III AND IV

In each of the following examples, 1.5-denier rayon fibers were cut to the designated lengths and uniformly deposited on a wire screen. The fibers were sprayed with a resin binder such that the finished web had a 31 percent on a dry basis of solids applied thereto. The finished sheets were uniform in texture and appearance and had the indicated strengths.

Example No.	Fiber length in inches	Tensile strength of sheet in grams per inch of width
II	0.09	760
III	0.19	1450
IV	0.38	1660

While particular embodiments of the invention have been illustrated and described, it will be obvious to those skilled in the art that various changes and modifications can be made without departing from the spirit and scope of the invention and it is intended to cover in the appended claims all such changes and modifications that are within the scope of this invention.

What is claimed as new is:

1. A method of continuously making a uniform nonwoven web comprising the steps of:

a. feeding at least one strand of rayon tow into a cutter at a substantially uniform rate,

b. cutting said strand into short fiber bundles having a length of from 0.1 to 0.5 inch,

c. passing the fiber bundles through a centrifugal blower to substantially separate the individual fibers by contact with the rough peripheral inside surface of said blower,

d. dispersing said cut bundles randomly into individual fibers in a zone of high air shear,

e. depositing said individual fibers uniformly on the surface of a wire screen, and

f. spraying a binder on said fibers supported on said wire screen, and drying said binder to bond said fibers into a uniform nonwoven fabric having substantially uniform tensile strength in all directions.

2. A method of continuously making a uniform nonwoven web as claimed in claim 1 wherein said fiber bundles are cut to a length of from 0.2 to 0.4 inch.

3. A method of continuously making a uniform nonwoven web comprising the steps of:

a. feeding at least one strand of rayon tow into a cutter at a substantially uniform rate,

b. cutting said strand into short fiber bundles having a length of from 0.1 to 0.5 inch,

c. dispersing said cut bundles randomly into individual fibers in a zone of high air shear, said zone of high air shear including an air knife comprising a slot mounted in the wall of a chamber through which the fiber bundles are passed prior to deposition on said wire and injecting air through said slot at substantial velocity to completely separate the individual fibers from one another,

d. depositing said individual fibers uniformly on the surface of a wire screen, and

e. spraying a binder on said fibers supported on said wire screen, and drying said binder to bond said fibers into a uniform nonwoven fabric having substantially uniform tensile strength in all directions.

4. A method of continuously making a uniform nonwoven web as claimed in claim 3 wherein said fiber bundles are cut to a length of from 0.2 to 0.4 inch.

5. A method of continuously making a uniform nonwoven web as claimed in claim 3 including the intermediate step of passing the fiber bundles through a centrifugal blower to substantially separate the individual fibers by contact with the rough peripheral inside surface of said blower.

6. A method of continuously making a uniform nonwoven web as claimed in claim 5 wherein said fiber bundles are cut to a length of from 0.2 to 0.4 inch.