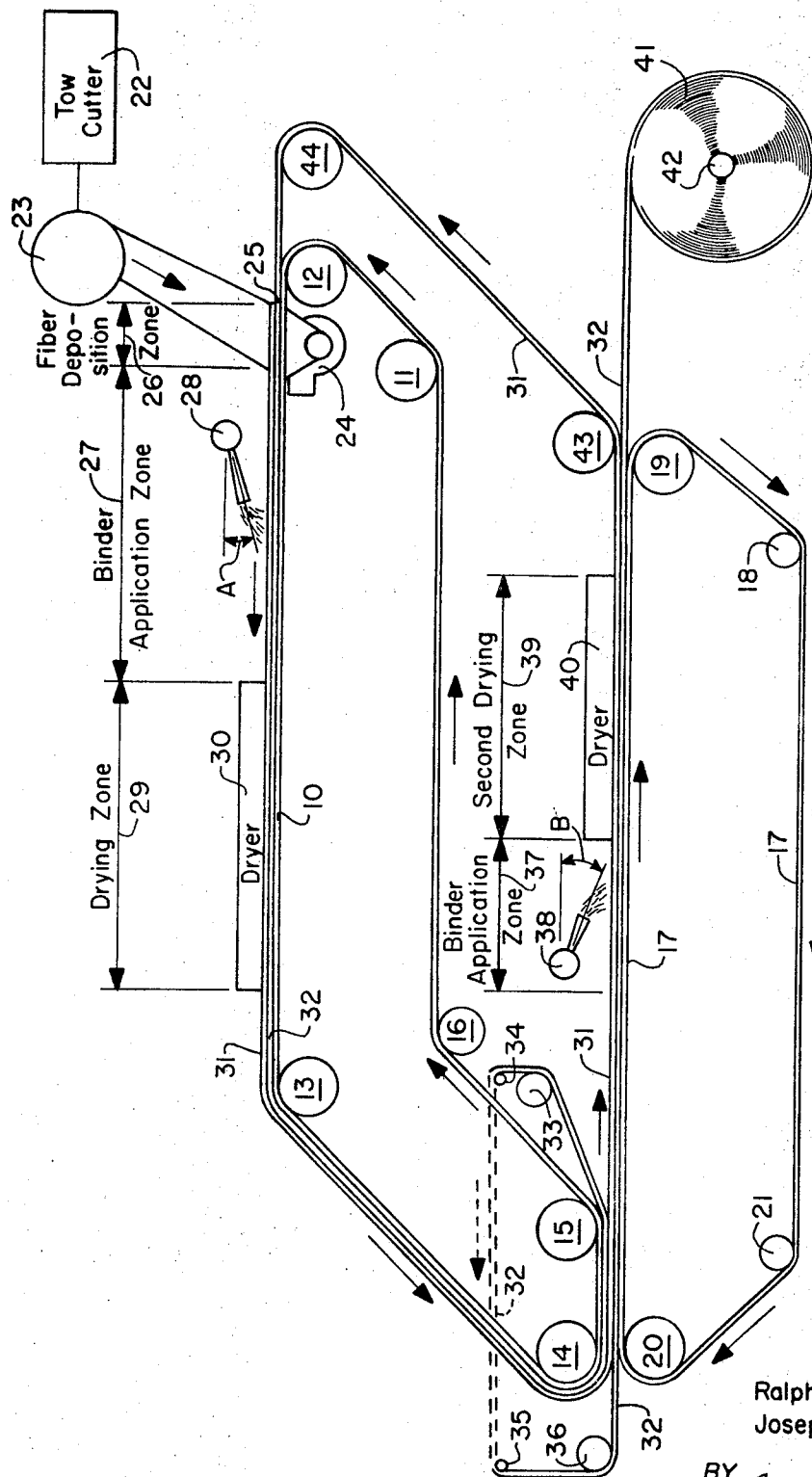


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PROCESS OF MAKING A NONWOVEN FABRIC

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**PROCESS OF MAKING A NONWOVEN FABRIC**  
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## ABSTRACT OF THE DISCLOSURE

A process of making a nonwoven fabric in which the newly completed nonwoven fabric is recycled and used as a moving support for new fabric web being formed until the latter becomes self-supporting. Then, the superposed webs are separated. The portion that was recycled is removed from the process; the newly completed web portion is continuously recycled as a moving support in the aforesaid manner.

## BACKGROUND OF THE INVENTION

In a typical process for making nonwoven fabric, a plurality of natural or synthetic fibers are deposited on a moving surface usually in the form of a fine mesh endless wire screen. A binder agent is applied on the fibers by spraying or otherwise to ultimately hold them together. On drying of the binder agent, a self-supporting web is formed whereupon additional operations may be performed subsequently such as curing, printing and the like. The finished nonwoven fabric web is continuously removed from the process whereupon it is rolled up on a suitable core.

This well known process has been found to have a serious deficiency when operated continuously for extended periods of time. That is, the binder agent tends to penetrate through the layer of deposited fibers. As a result some of the fiber particles become adhered to the supporting wire. This ultimately produces faults and small built-up areas on the wire surface which cause the formation of holes and/or other undesirable irregularities in the nonwoven fabric. There have been abortive suggestions in the prior art to clean the wire continuously by various means in order to avert these product imperfections. Another approach to solving the problem has been the suggested use of separate protective substrates but this, too, has not been generally successful since it complicates the process and adds a considerable cost factor which is not readily justified.

A principal object of the present invention is to provide a highly effective process improvement by which the above deficiencies can be remedied.

Another object of the invention is the provision of an improvement in the process of making nonwoven fabrics which eliminates the need for continuously cleaning the wire supporting screen in order to allow effective and efficient continuous operation of the process.

Still another object of the invention is the provision of an improved process of making nonwoven fabrics wherein the newly completed web is recycled and utilized as a supporting surface thereby eliminating the use of separate protective substrates such as tissue or fabric as has been suggested in the prior art. The elimination of such substrates vastly reduces the cost and complexity of operating the process and this, of course, is a most desirable objective.

## SUMMARY OF THE INVENTION

The nature and substance of the invention can be briefly summarized as comprising an improved process for making a nonwoven fabric which includes a first zone for uni-

formly depositing fibers on a moving support and a second zone for applying a binder to said fibers whereupon drying and curing may be effected. The completed nonwoven fabric web is recycled through the fiber deposition and drying zones where it serves as the moving support for subsequently formed nonwoven fabric in that fibers are uniformly deposited thereon in said first zone and subsequently have a binder applied thereto in said second zone to complete the nonwoven fabric which may be followed by drying and/or curing. The superposed webs are then separated such that the earlier formed fabric can be removed from the process. The more newly formed fabric is continuously recycled through the process in the same manner as its supporting web was previously recycled through the fiber deposition and binder application zones.

## BRIEF DESCRIPTION OF THE DRAWING

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter regarded as forming the present invention, it is believed the invention will be better understood from the following description taken in connection with the accompanying drawing in which:

The drawing illustrates schematically a preferred arrangement for carrying out the process of the invention.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the ensuing description reference will be made to fibers cut from viscose rayon tow in the preferred practice of the present invention. It will be understood, however, that this is primarily illustrative as the invention can be practiced with any of the fibers that are known and used in the making of nonwoven fabrics. Such fibers may include, by way of example, but not by way of limitation, other synthetic fibers including various forms of rayon such as cuprammonium rayon or other regenerated cellulosic fibers; cellulose ester fibers such as cellulose acetate and cellulose triacetate fibers; polyamide 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 including, but not limited to, cotton, wool, or silk. 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 that they are compatible in the desired blend.

It is not essential that all the fibers be cut to uniform length. In fact, the invention can be practiced with fibers of staple length, i.e., from about one-half inch in length up to about two and one-half or three inches in length. Shorter fibers, such as wood pulp fibers, cotton linters, asbestos linters, and the like, having lengths from about one-half inch down to about one-eighth inch or even less may be added in various proportions up to about fifty percent by weight, or even as high as one hundred percent by weight, particularly since the method of fabric formation as described herein is an air deposition technique which is preferred in the practice of the present invention.

While the invention is described hereinafter in the context of cutting fibers from a tow of rayon, it will be understood that the source of the fibers is immaterial to the practice of the recycle process of the invention. Thus the invention can be practiced as well by feeding staple fibers which have been opened and are dispersed by other means well known in the art such as cards, Rando feeders and the like.

The invention may be practiced in the formation of nonwoven fabrics wherein the fibers are randomly disposed and are not predominantly oriented in any one direction. On the other hand, the invention may be of equal utility

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in the practice of the production of nonwoven fabrics composed of textile fibers wherein the fibers are "oriented" predominantly in one direction. The invention is also of equal importance in the production of nonwoven fabrics wherein the fibers are basically and predominantly oriented in one direction but are also reorganized and rearranged in predetermined designs and patterns of fabric openings and fiber bundles. In general, the structure of the nonwoven fabric is not critical in the practice of the process of the present invention.

Referring now to the drawing, the preferred process of the present invention will be described in the context of the schematic illustration by which it is most readily described.

The process is preferably carried out in an apparatus having an upper endless wire or screen 10 which is supported for continuous movement by the rolls 11, 12, 13, 14, 15 and 16. A lower endless wire or screen 17 is provided which is supported for movement over the rolls 18, 19, 20 and 21.

The structure and details of the wires 10 and 17, as well as their supports, will be well known to persons skilled in the art of making nonwoven fabrics. It is of interest to note that the process is preferably carried out on wires having a mesh of from about 10 to about 60 wires per inch and ideally 20 wires per inch. The wires 10 and 17 are suitably driven such that their surface speeds correspond to the speeds at which the nonwoven fabric is being manufactured. For practical purposes these speeds can range from about 10 feet per minute to about 1200 feet per minute.

Rayon fibers are continuously cut from a rope of tow of 200,000 total denier containing between about 40,000 and about 133,000 strands each of about 1.5 to about 5.0 denier into uniform lengths in the range of from about 0.1 inch to about 0.5 inch; a substantially uniform length of about 0.3 inch is preferred. The tow is severed in the cutter 22 whereupon the fibers are conveyed to a dispersion device 23 which preferably may consist of a centrifugal blower which subjects the individual fibers to shear forces to separate residual fiber bundles. The fiber laden air stream is passed downwardly with the aid of the suction blower 24 whereupon the fibers are deposited randomly and uniformly on a support surface 25 as it passes into the processing zones, the first of which is the fiber deposition zone 26. As will be more fully explained hereinafter, the support surface 25 is, in fact, previously formed and completed nonwoven fabric which is recycled and supported by the wire 10 beyond the roll 12.

A second zone 27 is provided over the wire 10 for applying a suitable binder to the fibers previously deposited in the first zone 26. The binder application zone 27 may comprise one or more spray nozzles 28 which uniformly apply a coating of binder material on the fibers as they move forward on the support surface 25. The particular type of binder used may be selected from a large group of binders that are well known in the industry for such purposes. Preferably the binder can be any one or a combination of resins such as the (poly)acrylates or polymers of styrene/butadiene in a water dispersion.

After applying the binder material, the wetted fibers may be passed through a drying zone 29 wherein the remaining solvent (i.e. water) is driven off from the binder solution such that the fibers are held together to form a nonwoven fabric which is substantially self-supporting. The dryer element 30 in the drying zone 29 may consist of a source of hot air, or of infra-red radiation.

The more newly completed nonwoven web 31 (beyond the drying zone 29) is passed downwardly in superposed relation with the supporting web 32 (formerly the support surface 25) over the rolls 13 and 14 until the webs pass beneath the roll 15. The more newly completed nonwoven web 31 is then separated from its supporting web 32 of nonwoven fabric material as the webs pass beyond the roll 15. The supporting web 32 then passes upwardly and

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around the roll 33 to a pair of folding bars represented schematically by the reference numeral 34. The folding bars 34 guide the moving supporting web 32 outwardly away from the plane of the drawing until it is clear of the plane of the moving wires 10 and 17. The supporting web 32 is then fed forward as represented by the broken lines whereupon it is threaded over a second set of turning bars shown schematically at 35 which return the web 32 into its original vertical plane. The supporting web 32 then passes over the roll 36 whereupon it is fed into the nip between rollers 14 and 20 beneath the more newly completed nonwoven web 31 to act as a support as the latter is passed on for additional processing.

The more newly completed nonwoven web 31 is carried forward beyond the roll 15 supported by the web 32 which in turn is carried by the lower wire 17. It is a preferred practice to spray a coating of binder on the underside (as contrasted to the surface sprayed in the zone 27) of the web 31. This can be accomplished by spraying in the zone 37 by means of one or more nozzles 38. The binder may be of the same composition used in the binder application zone 27. The wetted web 31 is dried subsequently in the drying zone 39 by means of the dryer 40 which can be of similar design and construction as the dryer 30 in the drying zone 29. After completing its support function in the zones 37 and 39, the supporting web 32 is removed beyond the roll 19 and formed into a finished product roll 41 on the core 42.

The more newly completed nonwoven web 31 is then passed over the rolls 43 and 44 whereupon its function becomes that of the supporting surface 25 as it passes beneath the dispersion device 23 and through the first or deposition zone 26 wherein new fibers are being continuously deposited thereon as previously carried out with regard to its own formation. In other words, the more newly completed nonwoven web 31 is recycled through the zones 26, 27 and 29 during which time it functions as the support surface 25 for the nonwoven fabric being formed until it emerges from the drying zone 29 as the supporting web 32. The supporting web 32 continues its recycle path until it ultimately emerges to be wound on the roll 41.

In the drawing, the nozzles 28 and 38 are shown mounted at angles A and B, respectively. In each case the angle is measured between the axis of the orifice of the nozzle and a plane parallel to the wires 10 and 17, respectively. These angles can be varied to obtain the most desirable results. The angles are dependent on such variables as type of nozzle, nozzle pressure, web speed, binder composition and the like as will be appreciated by those skilled in the art. In practice it has been found that the angles can be varied between about 0° and 90° although an angle of about 10° is preferred. The optimum angle for a given set of operating conditions can be determined in the course of practicing the process.

In the foregoing discussion, the recycled nonwoven web 32 has been described as a support for the more newly formed and/or completed web 31 in passing successively through the zones 26, 27, 29 and 37, 39. In both cases, the web 32 is illustrated and described as being supported by the wires 10 and 17 respectively. In some instances it may be feasible and desirable to guide the wires 10 and 17 such that the web 32 forms the sole support for the fabric being processed through the zones 27, 29 and 37, 39. This will positively eliminate adherence of binder material on the screens 10 and 17 as there will be no opportunity for the binder to penetrate to the wire before the fabric is dried.

In some cases the strength of the nonwoven product is not particularly critical so that the application of binder material on the reverse side of the web in zone 37 is not needed. In such cases, the zones 37 and 39 may be eliminated or inactivated from the process. This also simplifies handling of the supporting web 32 since it permits winding of the finished web in the approximate area of the roll 33 thus further simplifying the process by avoiding the

need for pairs of turning bars 34, 35 as heretofore described.

The operation of the process can be inaugurated before any nonwoven web has been produced by the use of a foreign substrate of porous paper or a length of nonwoven fabric from a prior use of the process. A leader of the foreign substrate is placed in operative position in the process as by threading through a suitable apparatus. The process is initiated by applying fibers and binder on this leader until a sheet of sufficient length and integrity is obtained, at which point the leader is severed or otherwise discontinued. Alternatively, a sufficient length of fabric may be left in the process or apparatus for practicing same when it is shut down from a previous run.

As described heretofore, the recycled web serves as a moving support surface for the continuous formation of the nonwoven fabric material in the form of a web. It is also possible to practice the present process in such a manner that the more newly completed nonwoven web 31 may be inverted prior to initiating its function as a support surface 25. That is, the lower surface, as formed, acts as the support surface 25 as the web is recycled through the zones 26, 27 and 29.

While in the preferred embodiment a spray bonding step is described in the second zone 27, it will be understood that other forms of bonding may be used in making the nonwoven fabric such as print bonding, although saturation bonding as by dipping should be avoided. Additional steps such as decoration or embossing may be carried out concurrently. Other supporting means such as rolls or slides may be present under both webs during at least a portion of their travel through the process. The supporting web 32 may continue through several additional process steps such as extra drying and/or curing before removal from the process. In some circumstances it may even be desirable to remove the web after the binder has been applied to the supporting web and before passage through any specific drying step.

#### EXAMPLE I

An apparatus having a configuration substantially as illustrated in the drawing was operated continuously by feeding four tows of rayon into the cutter 22. Each tow had 200,000 total denier and consisted of 133,000 strands each of 1.5 denier. The cutter was adjusted to cut the tow into individual fibers having a length of .260 inch at a tow feed rate of 1.32 pounds per minute. The cut fibers were conveyed to the dispersing device 23 which consisted of a centrifugal blower passing 14,000 c.f.m., operated at a speed of 2050 r.p.m. whereby the fibers were randomly dispersed and drawn downwardly by the suction blower 24. The fibers were deposited over a width of 20.5 inches on the support surface 25 which consisted of the previously formed nonwoven fabric web as it passed through the zone 26. The supporting web 32 was of 24.7 grams per square yard basis weight and contained 18% by weight of Rohm and Haas HA-8 acrylic resin binder and 7% by weight of Rohm and Haas HA-12 acrylic resin binder. The wire 10 had a width of 24 inches and a mesh of 20 wires per inch; it was moved at a speed of 185 feet per minute.

As a nonwoven web 31 was passed through the zone 26 as a support surface 25, the fibers were deposited randomly and uniformly thereon. As the support surface 25 supported by the wire 10 moved forward it passed beneath a spray nozzle 28 which was a type 8003-E nozzle made by Spraying Systems Company of Bellwood, Ill. The nozzle was operated at 118 p.s.i.g. and was mounted such that the angle A was equal to 10°. Rohm and Haas HA-8 acrylic resin binder was uniformly sprayed from the nozzle 28 so that the finished web contained 18% by weight of resin deposited at this step. The fibers were then passed through the drying zone 29. The dryer 30 consisted of a flow through hot air drying oven which dried the binder material and caused the fibers to become bonded and thus

form a self-supporting nonwoven web 31 in superposition with the web 32. The supporting web 32 was then manipulated so that it was in superposition with the other surface of the more newly completed nonwoven web 31 and the two webs were carried forward through the zones 37 and 39 supported by the wire 17. In the zone 37, a spray nozzle 38 of type 8002-E manufactured by Spraying Systems Company was mounted so that the angle B was equal to 10°. The nozzle 38 was operated at 112 p.s.i.g. and deposited Rohm and Haas HA-12 acrylic resin binder uniformly on the web 31 so that the finished web contained 7% by weight of resin deposited at this step. The dryer 40 consisted of a flow through hot air drying oven which dried the binder material to complete the nonwoven web 31.

The supporting web 32 was then removed from the process and the newly completed nonwoven web 31 was recycled to serve as a supporting surface 25 and was moved through the previously described treating zones. In doing so fibers were deposited and then sprayed and dried in the same manner as previously described for the completed web. The process was continuously operated for four hours during which 459 pounds of nonwoven fabric having 24.7 grams per square yard basis weight were manufactured.

During the period of operating the above process, the screens 10 and 17 had no binder material or fabric particles adhered thereto such that the finished web was completely uniform and free of defects.

#### EXAMPLE II

An apparatus having a configuration substantially as illustrated in the drawing is operated continuously by feeding four tows of rayon into the cutter 22. Each tow has 200,000 total denier and consists of 133,000 strands each of 1.5 denier. The cutter is adjusted to cut the tow into individual fibers with a length of .260 inch at a tow feed rate of 1.32 pounds per minute. The cut fibers are conveyed to the dispersing device 23 which consists of a centrifugal blower passing 14,000 c.f.m., operated at a speed of 2050 r.p.m. whereby the fibers are randomly dispersed and drawn downwardly by the suction blower 24. The fibers are deposited over a width of 20.5 inches on the support surface 25 consisting of the previously formed nonwoven fabric web as it passes through the zone 26. The supporting web 32 is of 24.7 grams per square yard basis weight and contains 25% by weight of Rohm and Haas HA-8 acrylic resin binder. The wire 10 is 24 inches wide and of 20 wires per inch mesh; it moves at 185 feet per minute.

As the nonwoven web 31 is passed through the zone 26 as a support surface 25, the fibers are deposited randomly and uniformly thereon. As the support surface 25 supported by the wire 10 is moved forward it passes beneath a spray nozzle 28 which is a type 8003-E nozzle made by Spraying Systems Company of Bellwood, Ill. The nozzle is operated at 118 p.s.i.g. and is mounted such that the angle A is 10°. Rohm and Haas HA-8 acrylic resin binder is uniformly sprayed from the nozzle 28 so that the finished web contains 25% by weight of resin deposited at this step. The fibers are then passed through the drying zone 29. The dryer 30 consists of a flow through hot air drying oven which dries the binder material and causes the fibers to become bonded and thus form a self-supporting nonwoven web 31 in superposition with the web 32.

The supporting web 32 is then removed from the process and the newly completed nonwoven web 31 is recycled to serve as a supporting surface 25 and is moved through the previously described treating zones. In doing so fibers are deposited and then sprayed and then dried in the same manner as previously described for the completed web. The process is continuously operated for four hours such that 459 pounds of nonwoven fabric having 24.7 grams/square yard basis weight are manufactured.

During the period of operating the above process, the screen 10 has no binder material or fabric particles adhered thereto such that the finished web is completely uniform and free of defects.

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 process of making a nonwoven fabric including a first zone for uniformly depositing fibers on a moving support surface consisting of a supporting web of nonwoven fabric material and a second zone for applying a binder to said fibers to form a more newly completed nonwoven web of fabric material from said fibers, the improvement comprising the steps of:

- (a) recycling the more newly completed nonwoven web of fabric material through said zones wherein it serves as said moving support surface, and
- (b) uniformly depositing fibers on said moving support surface in said first zone, applying a binder on said deposited fibers in said second zone to continuously form a more newly completed nonwoven fabric web superposed on said supporting web of nonwoven fabric material, and
- (c) separating said webs and recycling said more newly completed nonwoven fabric web in the same manner as the previously recycled completed nonwoven fabric web.

2. A process of making a nonwoven fabric as claimed in claim 1 including the steps of:

- (a) placing said supporting web in superposition on

the first side of said more newly completed nonwoven web, and

- (b) applying a binder on the underside of said more newly completed nonwoven fabric web.

3. A process of making a nonwoven fabric as claimed in claim 1 in which a drying zone is located immediately adjacent said second zone, the additional step of recycling the supporting web of nonwoven fabric material through each of said zones including said drying zone.

4. A process of making a nonwoven fabric as claimed in claim 1 including the step of inverting said more newly completed nonwoven web of fabric material prior to said recycling step such that the lower surface of the more newly completed nonwoven fabric web acts as the support surface as said web is recycled through said zones.

5. A process of making a nonwoven fabric as claimed in claim 2 in which a drying zone is located immediately adjacent said second zone, the additional step of recycling the supporting web of nonwoven fabric material through each of said zones including said drying zone.

6. A process of making a nonwoven fabric as claimed in either of claims 2 or 5 including the step of drying said more newly completed nonwoven fabric web after applying a binder to its undersurface.

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