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METHOD OF MANUFACTURING WEBS

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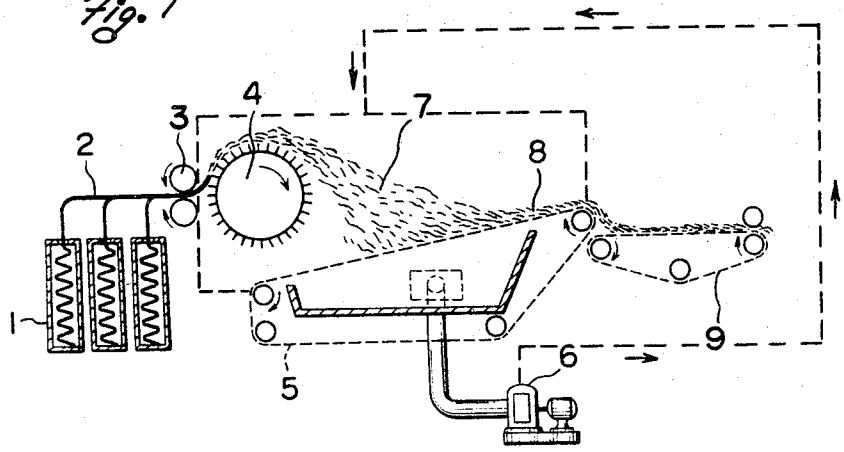
Fig. 1



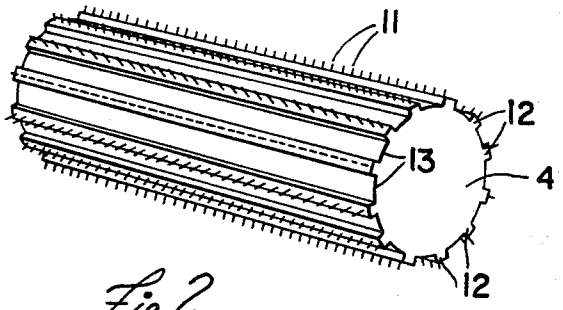


Fig. 2

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METHOD OF MANUFACTURING WEBS

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1 Claim. (Cl. 19—156.3)

The present invention relates to an improved method for forming nonwoven webs in the form of a sheet or a mat, and particularly to an improved method for forming synthetic fibers or natural fibers into webs of the aforesaid type for use as waterproof material or filters for industrial purposes.

Cloth-like or sheet-form webs formed with textile fibers without processing such fibers through a spinning machine, a weaving machine or a knitting machine are used for a variety of purposes. For example, webs of the aforesaid type which are formed by binding together the fibers by impregnating them with a thermoplastic or rubber-like binder, or webs formed by partially fusing thermoplastic fibers, are known as the so-called "nonwoven fabrics." Such processed webs have many uses. For example, there are processed webs which are used as clothing materials, imitation leathers, packing materials, construction materials, and also those for industrial purposes as, for example, filter cloths.

In addition, webs are produced by the so-called "wet" methods which includes methods using paper-manufacturing machines and other webs are obtained by means of still further web forming processes which are commonly called "dry" methods. The latter are exemplified by several types of methods, one of which comprises the steps of forming cotton-form fibers into a thin layer of web through a carding machine or a garnetting machine and laminating such layers into a plurality of layers of a desired thickness. Another method, called the Proctor & Schwaltz method, comprises the step of scattering thinly accumulated layers of fibers in a pressurized air current. Still another method, called the "Rando Webber" method, is the combination of such a fiber scattering method and a hopper feeding method. These methods, however, invariably use fibers prepared in the form of raw cotton wool as the starting material. The nature of these fibers which are used as the starting material, especially the lengths, the fineness, and the degree of the crimp of the cut fibers, are drastically restricted by the limited ability of the individual apparatus such as the hopper and the carding machine which are used in the manufacture of webs. More specifically, the fineness of the fibers which are used most often is in the range from 1 to 7 denier, and fibers with a greater fineness such as 10 denier are seldom used. It has been found difficult to use fibers of greater denier in the manufacture of webs. The usual length of cut fibers is in the range from 3 to 5 cm., and the maximum length is in the order of 7 to 8 cm. The use of fibers longer than this limit makes it difficult to manufacture a web of uniform quality. Also it has been found difficult to form a web of commercially acceptable quality with fibers which have not had crimps imparted thereto. In view of the foregoing reasons, the webs which were obtained by the aforesaid conventional methods were often found to be too poor in strength and too soft to be safely accepted as industrial material.

The invention described herein eliminates the aforestated drawbacks of the conventional webs and produces webs with desirable properties by a combination of two features, namely, adequately selected starting fibers and a processing procedure matched with the selected fibers. The invention provides a novel and improved method for manufacturing webs that not only solves all the difficulties encountered in the webs manufactured by the conventional methods as have been discussed above, but also satisfied all of the desired objects which will be described later herein.

An object of the present invention, therefore, is to provide an improved method for manufacturing nonwoven fiber webs.

Another object of the present invention is to provide a method of manufacturing such webs having a property represented by increased strength and rigidity.

Still another object of the present invention is to provide a method of manufacturing webs having such an improved property as is represented by increased strength and rigidity and being suited for being used for many purposes.

Yet another object of the present invention is to provide a method of manufacturing webs which permits an increased efficiency and economy in the processing of the starting fibers.

The foregoing, as well as the other objects and advantages of the present invention, will become apparent by reading the following detailed description in connection with the accompanying drawing. FIGURE 1 is a schematic illustration of apparatus for performing the steps of the method of the invention. FIGURE 2 is a perspective view of the needle roll of the apparatus.

According to the method of the present invention, the starting fibers used are limited to either synthetic filament tows of regular type, or stiff and lengthy natural fibers instead of such fibers which have been preliminarily converted into raw cotton wool form as have been used in the conventional methods. The purport of the present invention lies in that the webs are formed by the following procedure which comprises the steps of: preparing slivers of such starting filaments or fibers as have been described above by a known method; feeding the formed slivers between a pair of rotating nip rollers; receiving the outcoming rolled slivers continuously in a substantially uniform amount on a needled roller disposed at the discharge side of the nip rollers; spreading the staple fibers by virtue of the mechanical fiber separation action of said needled roller and also by virtue of the pressurized air current created by the rotation of said needled roller; and accumulating the spread staple fibers on the surface of a travelling net-form air-permeable belt of a conveyor of the next stage by virtue of a suction force applied to said conveyor from under the belt.

The preferred starting fibers used in the present invention are comprised of synthetic filament tows of regular type made of materials such as vinylon, nylon, polyester, polyethylene, polypropylene or polyvinylidene chloride. However, natural fibers such as Manila hemp fibers, Sisal hemp fibers, jute fibers or ramie fibers may also be used, provided that they are lengthy fibers with a considerably coarse degree of fineness. In case synthetic filament tows are used, there is the particular advantage in that the individual monofilaments constituting the tows may have a fineness of a wide range from 1 denier to 500 denier, more or less.

In putting the method of the present invention into practice, the operation first begins with converting such starting filaments as have been discussed into slivers. In the case where synthetic filament tows are used as the starting material, such tows are broken or cut into a desired length by a Perlock type breaker, a tarbo-stapler, a Pacific convertor or like means, whereby to form the tows into slivers. The permissible range of the length of the individual fibers for constituting a sliver is from 50 mm. to 1000 mm., more or less. In the case where natural fibers are used as the starting material, the starting fibers are used either without cutting them or after the fibers are cut into a desired length; and the cut fibers are suc-

cessively subjected to a breaker, a spreader and a finisher of a drawing machine to form in a conventional and well known manner the cut fibers into slivers. Where the fineness of the monofilaments of the synthetic filament tows is so fine as is several scores of denier or less, the tows can be made in slivers through a breaker-type apparatus. In the case where monofilaments of greater fineness measurement are used, it is preferred to cut the filaments into a desired length before such filaments are converted into slivers through a drawing machine, as in the case where natural fibers are used.

Webs are manufactured from the slivers which are obtained in such manner as has been described above. A description will now be made of the steps of manufacturing webs by referring to the drawing.

A plurality of cans generally indicated by reference numeral **1**, each containing a run of sliver **2**, are disposed at uniform spaced intervals in a row. Each run of sliver from these cans is fed in succession to a pair of nip rollers **3** comprising an upper roller and a lower roller. This pair of rollers **3** is rotated at a constant, low speed. The sliver fed to the nip rollers is seized firmly between the circumferences of the pair of rollers and fed further to the next step. At the discharge side of the nip rollers is provided a needled roller **4** which has a peripheral speed and a diameter markedly greater than those of the nip rollers. The sliver, which is discharged from the nip rollers, is loosened when it is brought into contact with the needles extending radially from the surface of the roller, and the fibers are separated from each other by the needles. At the moment that the end edge of each individual fiber has passed the point of nipping of the nip rollers, said individual fiber, which is partially engaged by the needles, is drawn forward in the rotational direction of the roller by virtue of the pulling force of the needles. The fiber which now has been drawn completely out of engagement by the nip rollers and is now located on the needles of the needled roller is driven by the air current which is produced by the rotation of the needled roller to be transferred onto the web-forming, net-form belt of the conveyor **5** of the next stage. In view of the fact that the individual staple fibers have been uniformly distributed within the sliver as a whole and that the ends of the individual staple fibers constituting the sliver are located in random directions and at random positions within the sliver, the individual staple fibers **7** which have passed the nip point of the nip rollers **3** are fed always in a continuous uniform mass and accordingly a uniform amount of fibers is transferred continuously onto the surface of the belt.

The conveyor belt **5** is comprised of an endless belt of wire net and the belt is so designed that the ambient air on the upper surface of the belt is sucked through to the other side of the net by virtue of the suction force created by the exhausting fan **6**. The individual staple fibers which have been spread by the blowing action of the needled roller fall on the surface of the constantly moving net of the conveyor one after another, and while being subjected to the suction force produced on the net, the fibers are accumulated on the net in random directions and are thus formed into a web **8** having a substantially uniform thickness all over as a web. The constantly produced web sheet is transferred successively to a transfer conveyor **9** disposed ahead of the belt conveyor **5** to discharge the web as a product. The web thus obtained is now subjected, as desired, to treatment according to the purposes.

One thing which requires attention in the web manufacturing procedure of the present invention is the structure of the needled roller. In case a roller which has sliver-loosening and fiber-separating needles merely planted on the periphery of the roller is used, no satisfactory air current is produced by the rotation of such roller, and this leads to the result that a number of staple fibers become entangled with the needles and the entangled staple fibers gradually become accumulated there to cause impairment of the fiber-separating function of the needles. Furthermore, the accumulated mass of staple fibers, after reaching a certain volume, becomes separated therefrom one mass after another and contributes to making the thickness of the formed web uneven. Because of the foregoing reason, the preferred type of needled roller which is used in the present invention is of the structure that the needles **11** are secured to bars **12** which are, in turn, disposed on the periphery of a roller and extend longitudinally thereof at spaced intervals relative to the rotational direction of the roller, or of the structure wherein the roller is provided with a plurality of grooves or narrow recesses **13** of a substantial depth disposed longitudinally on the periphery of the roller and the needles are planted on each ridge **12** between the grooves. Anyway, it is preferred to use a roller which is provided with appropriately narrow recesses of a substantial depth or with like formation on the periphery. By this arrangement, when the roller is rotated at a high speed, the recesses or the grooves formed on the periphery of the roller work as a kind of windmill and creates a strong current of air in the direction of the rotation of the roller. The air current prevents the staple fibers from being tangled about the needles and permits the entire staple fibers to be easily separated from each other and to be scattered.

The air which is sucked by virtue of the suction force produced by the exhausting fan may be recycled, without being discharged outside the fan, as an air current to be applied onto the surface of the needled roller to assist the separation and scattering of the staple fibers carried by the needles of the roller.

According to the method of the prescent invention, there is provided an advantage that the starting fibers used may have a wide range of fineness and also may have, as a sliver, a long cut strength. Also, the webs manufactured according to the method of the present invention have no particular orientation of fibers and thus they are suited for being used as the material for industrial filters.

Next, description will be directed to some examples of the uses of the webs manufactured according to the method of the present invention.

A product which is made by first forming, according to the method of the present invention, a web of randomly oriented crimpless synthetic staple fibers made of such material as nylon, polyester or vinylon with a fineness of 2 to 3 denier and a length ranging from 150 mm. to 200 mm. and by thereafter subjecting the formed web to a needle locker machine to cause the individual fibers to be entangled with each other and by subsequently laminating the entangled fibers into a mat of a desired thickness, is suited as a filter for industrial use such as for filtering acidic or alkaline solutions, liquid form coating materials, lubricants or the like. This entangled staple fiber mat is also useful when used as a pad for making fiber reinforced plastics because of the fact that the mat is made of crimpless fibers.

A product which is made by first forming, according to the method of the present invention, a web of randomly oriented crimples synthetic staple fibers made of such material as polyester or vinylon with a fineness of 2 to 6 denier and a length in the range from 120 mm. to 150 mm. and by subsequently fixing and molding the staple fibers with the use of an appropriate amount of an appropriate type of binder such as rubber latex, synethetic resin emulsion, natural or synthetic glue of high molecular weight, provided, when used in combination with a bitumen such as asphalt, a high quality anti-corrosive coating material which may be applied to the surfaces of steel pipes which are to buried underground, or a high quality water-proof and moisture-proof pad for being used in the construction of basement rooms. Especially, the product which is made of the aforestated type of web and impregnated or coated with a material such as blown asphalt and molded into an asphalt roofing form shows remarkable strength and stretchability as compared with

similar products manufactured according to the conventional methods. A membrane water-proof laminated product having this latter processed product, which has just been described, as the pad displays a marked break-resistance and good resistance to the cracking tendency of the portions of buildings which are given water-proof treatment, and for this reason this product ensures outstanding reliability when used for such purposes.

A product which is made by first molding a web sheet manufactured according to the method of the present invention with a synthetic resin or rubber binder and by subsequently lining one side thereof with a film or sheet made of a material such as synthetic resin, rubber or like substances, and a product which is made by sandwiching such molded sheet between two films or sheets made of the aforesaid materials, are suited as reinforcement materials for flooring materials, tarpaulin cloths or like goods.

A product which is made by molding webs of stiff and lengthy fibers of Manila hemp or Sisal hemp with a coarse degree of fineness of several hundred denier into a mat form, according to the method of the present invention, is useful as an air filter or a cushion material.

Description will now be made on some of the preferred embodiments of the present invention. It should be understood, however, that the present invention is not restricted thereto, but that the scope of the present invention is defined by the claims affixed herewith.

EXAMPLE 1

Vinylon tows each having a total fineness of 1 million denier and comprising filaments with a fineness of 3 denier were formed, through Parlock type drawing machines, into slivers of staple fibers with an average length of 150 mm. and an average weight of 12.5 grams per meter. 20 runs of such slivers which were disposed at the distance of 50 mm. relative to each other in a row were fed to nip rollers which rotated at the peripheral speed of 20 meters per minute. The rolled sliver being discharged continuously from the nip rollers was received by a needled roller having needles of 50 mm. in length planted on the periphery thereof in rows which were disposed longitudinally to the circumference of the roller and spaced at 50 mm. intervals from each other relative to the rotational direction of the roller, with the needles in each row being spaced at 20 mm. distance from each other in the longitudinal direction of the roller, and with said roller being rotated at the peripheral speed of 960 meters per minute, and the fibers of the sliver were separated from each other by the needles. The individual staple fibers discharged from the needled roller by the air current created by the roller were accumulated on the surface of a travelling forming-net of a conveyor disposed adjacent to the needled roller, with the belt of net having an effective transverse width of 1 meter and running at the speed of 10 meters per minute. As a result, a uniform web of 500 g./m.^{2} which was comprised of randomly oriented staple fibers was obtained.

EXAMPLE 2

Sisal hemp fibers having an average length of 900 mm. and vinylon filaments of a fineness of 500 denier, which had been cut into a length of 900 mm. to be equal to that of the Sisal hemp fibers, were mixed in the ratio of 2 to 1. The mixture was fed to a drawing machine comprising a breaker, a spreader and a finisher, to convert in a conventional and well known manner the mixture of fibers into slivers. 20 runs of such slivers were fed to nip rollers rotating at the peripheral speed of 10 meters per minute. The sliver discharged from the nip rollers was treated in the same way as that in Example 1, and a web of uniform quality of 600 g./m.^{2} was obtained.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A method of manufacturing nonwoven webs from long, straight fibers, comprising the steps of:

forming slivers of crimpless, long, staple fibers having an approximate average length of at least about 120 millimeters with the fibers of said slivers being substantially free of entanglements with each other;

feeding said slivers in side-by-side relation between a pair of rotating nip rollers with the fibers in each sliver extending substantially parallel to the direction of movement of the slivers through the nip rollers;

forwarding said slivers away from the nip point of the nip rollers at a predetermined uniform relatively low speed to a separating and dispersing station spaced from the nip point;

engaging said fibers at said station by a plurality of individual, straight, radially extending needles which are moving through a closed circular path around a substantially horizontal axis, the needles moving at a relatively high speed substantially faster than the speed at which the slivers are fed to said needles and the needles combing, loosening and then separating the fibers of said slivers from each other after the trailing ends of said fibers have passed said nip point and projecting the fibers away from the needles;

simultaneously causing an air stream to flow outwardly between the needles to prevent the fibers from wrapping around the needles, the air stream being continuously supplied throughout the zone between said separating and dispersing station and the position at which the fibers are projected away from the needles to also assist in separating and projecting the fibers away from the needles;

simultaneously subjecting the fibers as they are projected away from the needles to a current of moving gas whereby said fibers are individually supported and carried to a gathering station; and

accumulating said separated and dispersed fibers in a sheet at said gathering station on the face of a travelling web.

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