United States Patent

Tachibana et al.

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[54] APPARATUS FOR PRODUCING NONWOVEN FABRICS

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Related U.S. Application Data

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[52] **U.S. Cl.**.....**425/83,** 18/4 B, 264/128, 425/104, 425/197, 425/202

[51] **Int. Cl.**.....**B29c 13/00,** B29c 27/10, D04h 1/64

[58] **Field of Search**.....18/4 B, 4 M, 4 P, 19 R, 5 A, 18/5 P; 264/128

[56] **References Cited**

UNITED STATES PATENTS

2,057,166	10/1936	Schur	264/128
2,577,784	12/1951	Lynam	264/128 X
2,847,701	8/1958	Welch	18/4 B
2,969,104	1/1961	Schubert et al.	18/4 B X
3,050,427	8/1962	Slayter et al.	264/128 X
3,171,151	3/1965	Sickle et al.	264/128 X
3,377,652	4/1968	Politzer et al.	18/4 B

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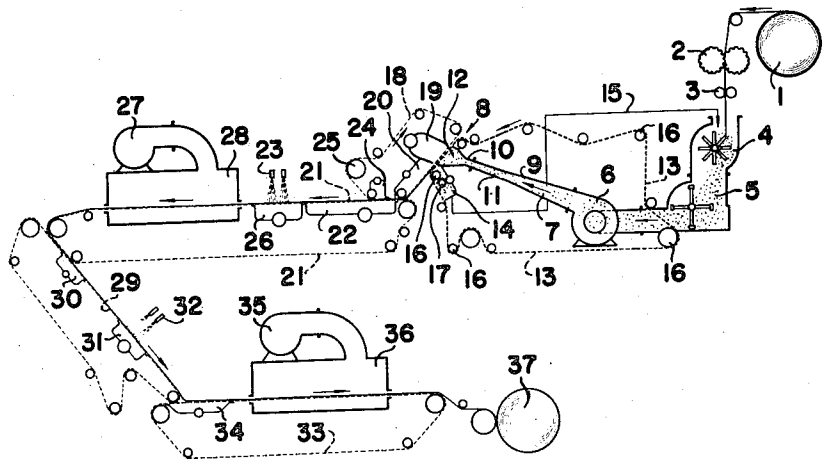
Assistant Examiner—R. L. Spicer, Jr.
Attorney—Bucknam and Archer

[57] **ABSTRACT**

An apparatus for producing nonwoven fabric comprising a duct for blowing fibers, a screen at the open end of said duct, a first endless wire-netting for receiving the fibers passed through said screen to form a band-shaped fiber mass on said first endless wire netting, a second endless wire-netting receiving said fiber mass from said first endless wire-netting, an adhesive sprayer provided at said second wire-netting, a suction section opposite to said sprayer, a dryer provided at said second wire-netting, a third endless wire-netting receiving said fiber mass from said second wire-netting, a second adhesive sprayer provided at said third wire-netting, a second suction section opposite to said second sprayer, a fourth endless wire-netting receiving said fiber mass from said third wire-netting, and a second dryer provided at said fourth wire-netting.

6 Claims, 7 Drawing Figures



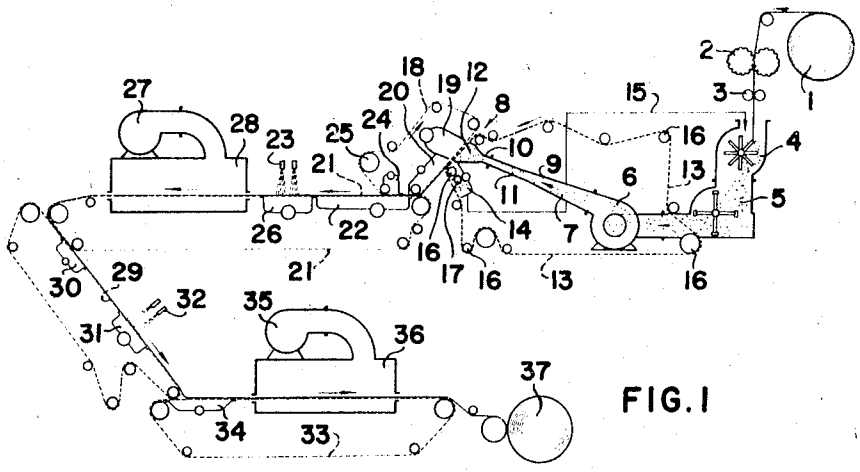


FIG. 1

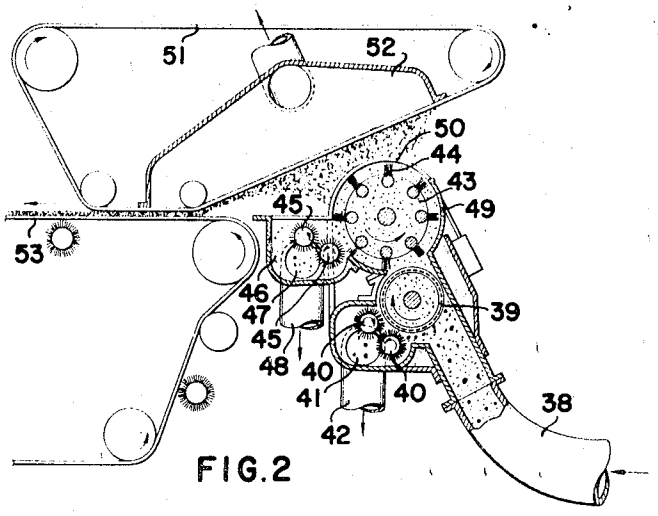


FIG. 2

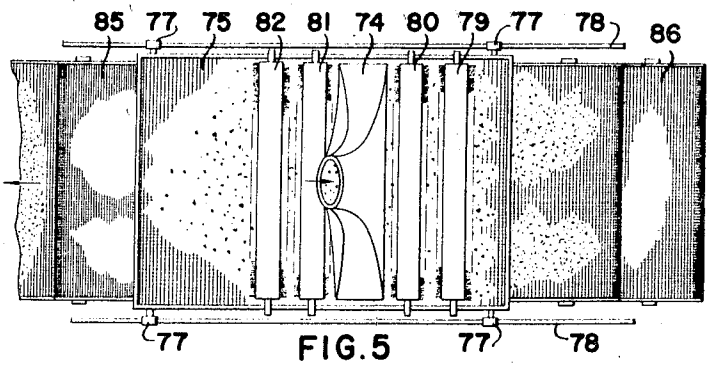


FIG. 5

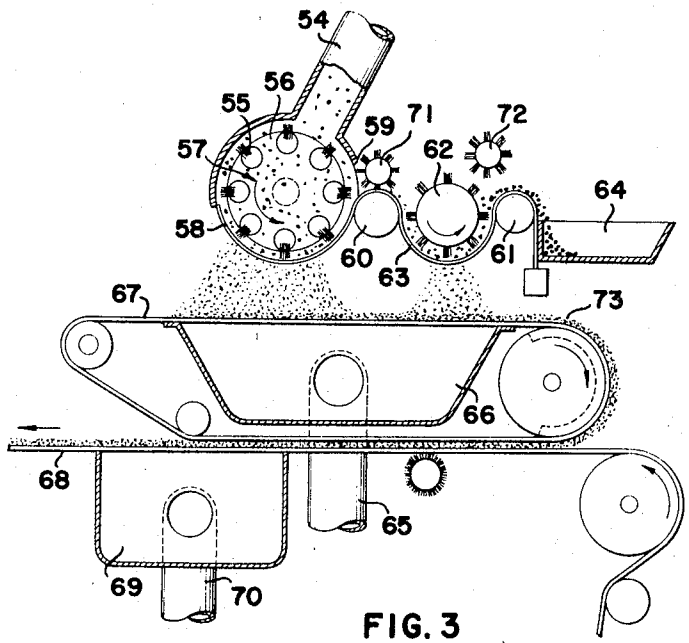

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FIG. 3

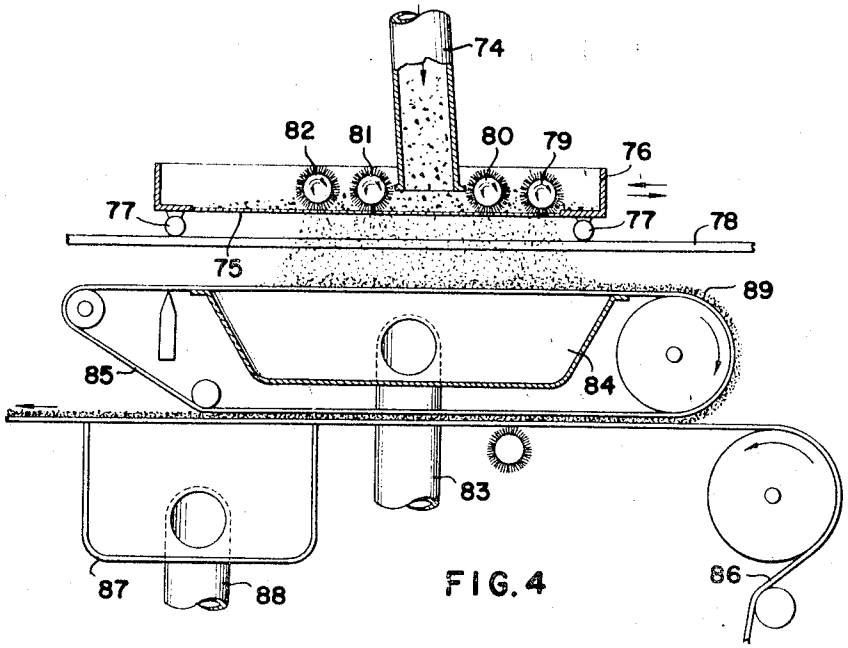
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FIG. 4

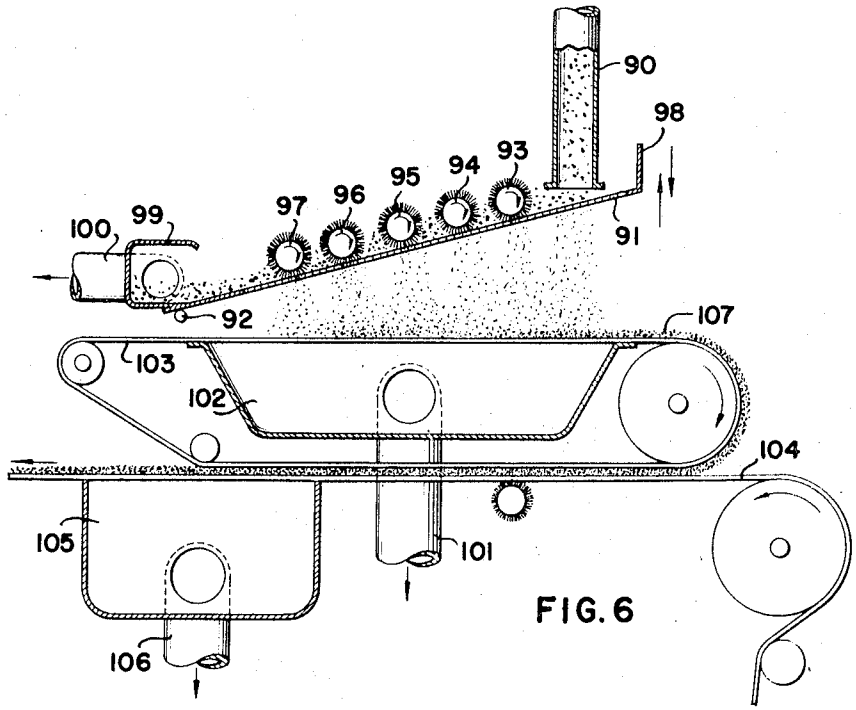
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FIG. 6

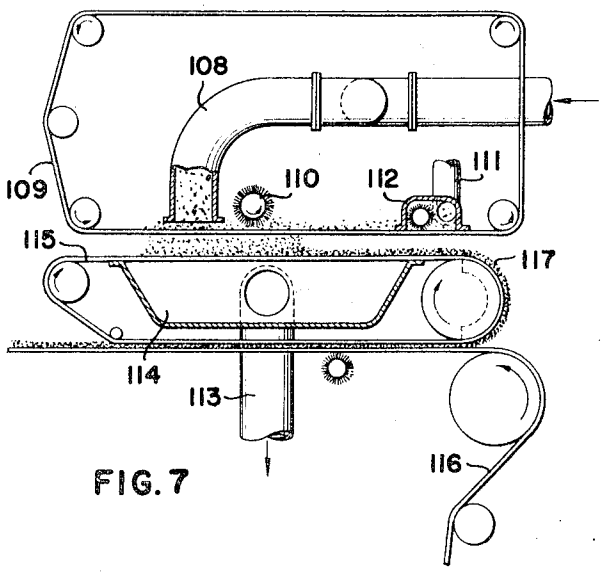
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FIG. 7

APPARATUS FOR PRODUCING NONWOVEN FABRICS

This application is a division of application Ser. No. 545,678, filed Apr. 27, 1966.

The present invention relates generally to the manufacture of nonwoven fabrics by using synthetic fibers, natural fibers or mixtures thereof, and particularly to an apparatus for producing voluminous and uniform nonwoven fabrics for cigarette filter tips especially from pulp fibers.

Conventionally known methods of manufacturing nonwoven fabrics by a dry process are the so-called carding method, garnett method and air lay method. These methods, however, have the following defects. Namely, the garnett method, for example, is chiefly designed for treatment of such synthetic fibers as having rather long fiber length, and is not suitable for treatment of natural fibers. This is attributable to the fact that, in the garnett method, the very short fibers such as natural fibers or some of synthetic fibers are liable to get stuffed in the spaces of the garnett machine, or otherwise a part of these fibers are often sucked up in the suction section, thus making it quite impossible to attain the intended object. Particularly, this method proves totally inefficient for the treatment of bonded fibers. This is the same case with the aforementioned carding method and air lay method.

Further, according to this garnett method, the certain inevitable limitations on the number of rotation of the garnett or the size of the serrated teeth result in a reduced amount of treatment. Thus, the nonwoven fabric producing apparatus employing this method had its unavoidable limitation in its treating rate. Particularly, impossibility of treatment of bonded fibers produces nonuniformity in the resulting texture. Moreover, according to this method, since the fibers are carded by the garnett, an undesirable orientation comes out in the fiber arrangement of the finished nonwoven fabrics and also a difference in strength between the lengthwise and transverse directions is produced in the resultant nonwoven fabrics.

According to the method of Japanese Pat. application Publication No. 12254/1960 which employs a combination of porous plates and brushes, it is often observed that the resulting fabrics have extremely close texture and are accompanied with flocks, because the structure of the apparatus as employed in this method is such that the rotating brushes are tightly attached in the inside of the porous plates which are formed into a closed chamber. Thus, both structurally and in terms of efficiency, it is hardly possible with this method to treat fibers in a large amount. Particularly, in the above-mentioned apparatus, the bonded fibers which are not unraveled stay in the inside of the unraveling chamber and move in accordance with rotation of the brushes, thereby causing even filament clusters, which are easily unraveled, to be sucked and the flocks to grow. As will thus be apparent, this method was by no means to be removed.

There is also known a method in which the eddy flow is applied to isolate fibers and then the bound fibers and nonbound fibers are sucked in at the sucking section thereby to produce nonwoven fabrics. This method, however, is defective in that the fibers are easily bonded in the chamber where the eddy flow is applied and that there is a certain limitation in capacity and other conditions of the chamber. These disadvantageous factors lead to production of nonwoven fabrics which contain bonded fibers which are not unraveled during the treating processes.

The aforementioned air lay method, in which the unraveled fibers blown with the air are jetted out of the nozzle through conduits, is also accompanied with difficulties in uniformly guiding the airstream onto the endless wire-netting and therefore often results in producing such nonwoven fabrics as having nonuniform texture.

As will be understood from the above, the conventional methods of producing nonwoven fabrics were almost inefficient in the treatment of short fibers like natural fibers and were also not satisfactory for producing nonwoven fabrics having uniform texture wherein the bonded fibers are completely unraveled.

The present invention is to provide an apparatus for producing nonwoven fabrics in which the above-mentioned defects seen in the conventional methods are eliminated. It is characteristic of producing voluminous nonwoven fabrics having uniform texture from comparatively short fibers at an extremely high rate, the resulting nonwoven fabrics being used particularly for cigarette filter tips.

There have been reported various methods for manufacturing cigarette filter tips by using synthetic fibers, semisynthetic fibers or natural fibers. But none of these methods are satisfactory. For example, in a proposed method in which the pulp of natural fibers mainly comprising cellulose is pulverized and then a powder adhesive is mixed in this pulp, the mixture being stuck to the cigarette filter tips and molded thereat by a powder adhering method. It is noted that the resulting products are expensive because of high cost of the powder adhesive available and that in the attempted mixing of the powdery adhesive in the pulverized pulp, there are often produced such portions where fibers and the adhesive are not bound. This is because the specific gravity and density of the pulverized pulp pieces differ from those of the adhesive and because it is impossible to mix the powdery adhesive in the bonded portions in the pulverized pulp.

Thus, when the mixture is molded into a filter tip, attached to a cigarette and then smoked, the pipe powder comprising the adhesive and fine fibers is inhaled along with the tobacco smoke into the mouth and into the lungs of the smoker, causing not only unpleasant feeling to the smoker but also harmful effects to the human system. Further, the sucking resistance and nicotin absorption at the time of smoking is not uniformly effected in this filter tip.

In another method in which thermoplastic fibers or the mixture of natural fibers and thermoplastic fibers are spread over the endless wire-netting and then embossed by, for example, heat gauzelike rolls, there are often produced unheated portions where the intended binding is not effected. Thus the material, when molded into a filter tip, gives rise to such inconveniences as mentioned above. Further, when the gauzelike heat pressure rolls are pressed to the synthetic fiber mass, there is produced nonuniformity in basis weight in grams per sq. meter and in thickness of the fiber mass, since the fibers are very likely to be attached to the heat rolls. Thus, when the materials are molded into the filter tips, difference of weight as well as suction resistance, hardness and nicotine absorbing rate is observed among individual products. Thus the quality of the resulting products is varied from one another. Further, according to this method, the fiber mass is formed with grooves having alternative ridges and valleys, which produces difference of density in the mass and may invite nonuniformity, when the mass is shaped into filter tips, and may consequently spoil the external appearance of the filter tip section. In case the cigarette filter tips are molded with the ridges being laid onto other ridges and the valleys onto other valleys, the sucking resistance is strengthened, thereby making it difficult to conduct comfortable smoking and to effect generally uniform filtering operation. Further, the difference of strength between the portions of ridges and valleys and the portions therebetween results in reduction of strength of the fiber mass as a whole and makes it difficult to put it to a high-speed molding machine. Thus, the obtained cigarette filter tips come expensive.

Whereas, when the nonwoven fabrics prepared according to the present invention are rolled up and then molded into filter tips, the above-said defects are overcome and excellent cigarette filter tips are obtained.

In the accompanying drawings:

FIG. 1 is a diagrammatic side view showing an apparatus according to this invention;

FIG. 2 is a fragmentary side view, partly in section, showing a modification of a portion of the apparatus shown in FIG. 1;

FIG. 3 is a fragmentary side view, partly in section, showing another modification of the portion of the apparatus shown in FIG. 1;

FIG. 4 is a fragmentary side view, partly in section, showing still another modification of the portion of the apparatus shown in FIG. 1;

FIG. 5 is a plan view of FIG. 4;

FIG. 6 is a fragmentary side view, partly in section, showing still another modification of the portion of the apparatus shown in FIG. 1; and

FIG. 7 is a fragmentary side view, partly in section, showing still another modification of the portion of the apparatus shown in FIG. 1.

As the fiber material, for example, bleached sulfite pulp of needle-leaf tree is delivered from the winder 1, then mollified by step rolls 2, then continuously conveyed portion by portion of a fixed amount by feeders 3 and further guided to the hammer mill 4 for crushing the material. In this hammer mill 4, above-said mollified fibers are unraveled still more finely and then further led to the perfecting hammer mill 5 of the next step. Thus the fibers are completely unraveled without any bonded fiber cluster remaining therein and then fed to the unraveling apparatus 7 and then to the band-shaped fiber mass forming section 8.

The unraveling apparatus 7 mainly consists of an air duct 9 extending upwardly from the fan 6, with a Venturi tube 11 having a narrow section 10 being provided in about the middle of said duct. Namely, the air duct 9 is comparatively broad in section at its connecting portion with the fan 6 and tapers off toward the tip where the narrow section 10 is formed. Passing the narrow section 10, the passage again opens wide and, while maintaining its fan-shaped section, is steadily spread out until it reaches the fiber-spraying section 12. As noted before, the fiber-perfecting operation by the hammer mill 5 does not necessarily provide complete separation of fibers into individual filaments; some fibers often remain unseparated in the form of flocks. It is also often observed that the individual filaments, while being carried by the air through the air duct 9, are entangled with one another due to their weight and shapes to produce flocks.

In this respect, the unraveling apparatus 7 is designed to inhibit as much as possible the creation of flocks and, when the flocks are irresistibly produced, to rapidly break them into individual filaments. In the unraveling apparatus 7, there is provided a Venturi tube 11 in halfway of the air duct 9, said Venturi tube being arranged adjacent to the band-shaped fiber mass forming section 8, so that the fibers conveyed with air through said duct are permitted to move riding on the airstream while making almost no rotation and, on arriving at the Venturi tube, their flowing velocity is sharply increased. Thus the change of flowing velocity, particularly rapid increase of velocity causes unbalance in speed of individual filaments and thereby breaks down the flocks. Thus separated fibers drift along with the airstream until they reach the band-shaped fiber mass forming section 8.

The filaments which were carried in this manner then collide, at the fiber-spraying section 12, with an endless coarse screen 13 which is of about 10 mesh which moves around the open face of said section. This screen 13 moves at such low speed as keeps undisturbed the airstream in the air duct 9 and permits most of said fibers or the fibers of proper length to pass therethrough to reach the endless wire-netting 18 arranged at the back side of the screen 13. The flocks of fibers which are unable to pass the screen 13 are suspended on the screen surface and forced to move downward with movement of the screen. Since a suction box 14 is provided closely below the fiber-spraying section 12, the flocks accumulated on the said screen surface are sucked and removed at the acting face of the suction box 14 and then returned to the hammer mill 4 through the air conduit 15. While those flocks which are attached to the guide roll 16 on the front side of the screen 13 are scraped off by the brush roll 17 of a smaller diameter and then guided to the hammer mill 4 through the air conduit 15. The fibers which have thus passed through the screen 13 are guided to the endless wire-netting 18 which moves in an opposite relation to the screen. This endless wire-netting is provided, at its back side, with a suction box 19 having powerful sucking strength, and the shape of the opening section of this suction box 19 is kept same as that of the fiber-spraying section 12. Consequently, the fibers arranged in the longitudinal direction pass through the screen 13 while maintaining the same direction, and also at the endless wire-netting, they are sucked while being orientated in the same direction. It follows, therefore, that the stronger is the suction strength, the closer to the endless wire-netting 18, that is, the suction strength is strong at the head of the fibers and weak at the tail. Since the head of the fibers is thus raised up more quickly, it is more likely that the fibers lie lengthwise. Thus, in the endless wire-netting 18, a thin layer of fallen fibers if formed only on the surface of said endless wire-netting, and the fibers reaching this layer thereafter having their heads stuck into this layer, whereby it becomes possible to form a band-shaped fiber mass in which many of the fiber are arranged lengthwise as a whole.

The fibers sucked to the endless wire-netting 18 move downward in accordance with travel of the endless wire-netting 18 while forming the band-shaped fiber mass and reaches the upper surface of the suction box 20 having comparatively weak suction action. There, the formed band-shaped fiber mass, while maintaining said arrangement of fibers therein, is conveyed and then transferred to another endless wire-netting 21 for conveyance purpose.

At the edge of the endless wire-netting 21, there is also provided a suction box 22 adjacent to the acting zone of said suction box 20, and by the sucking action thereof, the band-shaped fiber mass is brought onto the endless wire-netting for conveyance 21 without causing deformation of texture or change of density. In this case, since the back face of the band-shaped fiber mass on the endless wire-netting 18 comes out as the front face on the endless wire-netting 21, it is possible to render the back face of the band-shaped fiber mass on the endless wire-netting 21 into an even, flat face by making smaller the meshes of the endless wire-netting 18. Reference numeral 24 denotes the air outlet which facilitates transfer of the band-shaped fiber mass formed on the endless wire-netting 18 to the endless wire-netting for conveyance 21 and reference numeral 25 denotes the guide roll for the endless wire-netting fixing screen 18.

The endless wire-netting 21 is relatively large and long and provided, on its way, with an adhesive sprayer 23, a suction box 26 therefor and a dryer 28 having a hot air conduit 27. It is so arranged that while the band-shaped fiber mass is passed over the suction box 26 by the action of the endless wire-netting for conveyance 21, the adhesive is sprayed by the adhesive sprayer 23 and the adhesive sprayed and impregnated band-shaped fiber mass is successively passed through the dryer 28 to be thereby dried.

The adhesives to be used for nonwoven fabrics include styrene copolymers, polyvinyl acetate, polyvinyl chloride and polyacrylic ester. However, it is an important factor that the nonwoven fabrics used for cigarette filter tips are completely free from any hygienic problem. It is also required that such fabrics have sufficient hardness and elasticity to permit easy rollup to the form of cigarette filter tip and have sufficient resistance against heat mollification to stand the heat at the time of smoking and antihygroscopic property. As the adhesives which meet these requirements, preferably used are the solution polymers or emulsion of self-cross-linking synthetic resins of vinyl acetate system obtained by copolymerizing vinyl acetate, copolymers of vinyl acetate and acrylic ester or copolymers of vinyl acetate, acrylic ester and metaacrylic acid with amino group, amido group, methylol group or carboxyl group as the cross-linking radical or reaction radical.

As described above, nonwoven fabrics may be obtained by drying the band-shaped fiber mass sprayed and impregnated with an adhesive. However, in case of a high-speed manufacturing machine, the time permitted for the fiber mass to pass over the suction box 26 when the adhesive is sprayed is very short and also there are certain limitations in the amount of adhesive sprayed and the suction strength of the suction box

26, hence it is difficult to permeate the adhesive substantially deep into the band-shaped fiber mass. In such a case, it is desirous to transfer the dried nonwoven fabrics to another endless wire-netting for conveyance so that the front and back are reversed and then to again spray the adhesive. In such nonwoven fabrics which were prepared by applying adhesive only to one face of the band-shaped fiber mass, if the spray of adhesive should have not been enough to effect sufficiently deep permeation of the adhesive into the fabrics, there may consequently be produced nonbonded fibers, and these loose fibers in the finished products may be dispersed, thus spoiling the products. On the other hand, application of the adhesive on both sides of the band-shaped fiber mass will completely inhibit occurrence of nonbonded fibers and will also make possible utilization of a high-speed manufacturing machine, which will realize the low-cost production of nonwoven fabrics.

In this respect, arrangement is made such that another endless wire-netting 29 for conveyance purpose is provided confronting the progressing side of the endless wire-netting 21 also for conveyance purpose and that the dried band-shaped fiber mass is sucked in the suction box 30 and then transferred from the endless wire-netting 21 to another endless wire-netting 29. In this case, it will be noted that in the carrying endless wire-netting 29, the face of the band-shaped fiber mass on which no adhesive was sprayed comes out as the front face, therefore, the adhesive is sprayed on the new front face of the band-shaped fiber mass from the adhesive spraying apparatus 32 in the same manner as the preceding step when the fiber mass passes over the suction box 31.

This band-shaped fiber mass is successively transferred to still another transporting endless wire-netting 33 by the suction action of the suction box 34, then guided into the drier 36 having a hot air conduit 35 to be dried therein and then wound up at 37 as the finished products.

The arrangement shown in FIG. 2 is provided with a duct 38 through which the bleached kraft pulp fibers of needle-leaf tree, which were unraveled in the same manner as in FIG. 1, are brought in through an airblast fan. This duct 38 is arranged to face upward and at the top thereof, there is provided a hollow wire roll 39 comprising comparatively coarsely coiled wires. Said roll is always kept in a driven condition rotating in the direction of the reference arrow. At a side of said wire roll 39 are arranged two brush rolls 40, 40 of smaller diameter are arranged and disposed so as to be in contact with said roll 39. The brush rolls are arranged to rotate in the opposite directions to each other, and at the back of said brush rolls 40, 40 is provided an air inlet 41 which is communicated to the cyclone (not shown) through piping 42. There is also mounted a hollow, basket-formed larger brush roll 43 which is positioned above the wire roll 39 and is rotated counterclockwise, as shown in said figure. Said brush roll 43 is arranged so as to form a basketlike cylinder as a whole in which a plurality of brush bands 44 disposed perpendicular to the fiber blowing direction are arranged, each being spaced a certain interval from the discs on both sides. The brush bands 44 in the brush roll 43 are so arranged that the foremost ends thereof constantly brush the surface of the above-mentioned wire roll 39. At the lower side of the brush roll 43 are provided another brush rolls 45, 45 of smaller diameter which are arranged in contact with the roll 43 and are rotated in the opposite direction to each other as in the case of the wire roll 39. An air room 46 is also provided and encloses the brush rolls 45, 45. This air room has an air suction hole 47 through which the fibers scraped off by said brush rolls 45 are guided through piping 48 into said cyclone. There is formed an arc-shaped opening at the upper face of the basket-formed brush roll 43, with the remaining parts being kept airtight by casing 49. At the arc-shaped opening is provided a screen 50 extending along the front face of said roll 43. Above said screen 50, an endless wire-netting 51 comprising a wire-netting or a porous plate is suspended in a somewhat angled disposition. On the working face of said endless wire-netting 51 is provided a suction section or box 52.

The fibers carried by the air through the duct 38 are mixed separated filaments and nonseparated clustered fibers (flocks). This fiber group is first blown to the surface of the wire roll 39 rotating at the rate of 50 to 60 r.p.m. This roll 39 has the mesh openings of, for example, about 7 mesh, therefore, relatively large flocks in this fiber group blown to the roll are caught at the meshes of the wire roll 39 and while being kept stuck at the surface thereof, move with the rotation of the roll to reach the brush rolls 40, 40 of smaller diameter which rotate in contact with the side of said wire roll 39. Two brush rolls 40 and 40 rotate to the opposite directions to each other, and scrapes the conveyed flocks off here. Then the flocks are sucked into the inlet 41 behind the rolls, and are led into the cyclone through a pipeline 42. After passing the meshes of a wire-roll 39, processed fiber comes to a brush roll of basket type 43 traverse above the wire-roll and enters into the hollow roll, where it is blown away by centrifugal force and pressing force of the rotary roll rotating at the rate of 85 to 180 r.p.m., while it is unraveled by the action of brush-bands 44. The rotary motion of the brush roll 43 rubs fiber between edge of brush-bands 44 and a screen 50 of 5 to 15 mesh, and the fiber is completely unraveled to be sent out upwards.

Thus, unraveled fiber is adsorbed to an endless wire-netting 51, by the rotary motion of a brush roll of the basket type 43, air-blow by a fan and a suction box 52. On the other hand, residual fiber in the brush roll 43 is scraped off by two small brush rolls 45 and 45 to keep the brush 43 clean. Then the scraped fiber is returned into the cyclone through a suction hole 47 and a pipeline 48.

Adsorped fiber by the endless wire-netting 51 is conveyed in the form of a band-shaped mass, to be sprayed by adhesives and dried on the another conveyor belt 53 located under the endless wire-netting 51 with a small gap as is shown in FIG. 1 as an endless conveyor belt 21.

Thus, in this apparatus where unraveled fiber is adsorped to the endless wire-netting by air-blowing, flocks of fiber never drop on the band-shaped fiber mass to damage it, and therefore an uniform production is expected.

In the arrangement shown in FIG. 3, bleached kraft-pulp of needle-leaf trees, unraveled as is the case with FIG. 1 for instance, is guided into a duct 54 by a fan. Outlet of the duct is inclined downwardly, and is equipped with a scatterer of unraveled fiber. The scatterer consists of a screen 58 and a brush roll of basket type 57. The former is installed around the lower half part of the latter, which consists of a brush-belt 55 of brush-array arranged circularly and discs 56 to fasten it.

After the outlet 59, there is installed, separated by bars 60 and 61, an unraveling scatterer consisting of larger brush roll 62 and a screen 63. A flock reservoir 64 is also installed beside the scatterer. Besides, under it are an endless wire-netting 67 that travels over a suction box 66 driven by a suction tube 65, and another endless conveyor wire-netting 68 that travels under the endless wire-netting 67. (This conveyor wire-netting 68 corresponds to 21 in FIG. 1). Reference numeral 69 is a suction box driven by a suction tube 70, and 71 and 72 are brush rolls to scrape flocks out and 73 is band-shaped fiber mass.

Fiber material guided in the duct 54 by air-blow is introduced into the unraveling scatterer, and unraveled into filament by the brush-belt 55 and the screen 58 to be scattered through meshes of the screen 58. Nevertheless, some amount of material remains not unraveled, and meshes of a screen 58 would be choked without any step. To avoid it, remainder of flock is scraped out by a brush roll 71 and guided into the sub-unraveling scatterer, where larger brush roll 62 and a screen 63 unravel it into filament, to scatter through meshes of a screen 63. Furthermore, remainder of flock is again scraped out by a brush roll 72 and collected in a flock reservoir 64.

Scattered filament is sucked by the suction surface of an endless wire-netting 67, and as the wire-netting travels, band-shaped fiber mass is formed in turn. Then it is taken on the endless conveyor wire-netting 68 to be sprayed by adhesives and then to be dried as is shown in FIG. 1.

Thus, this apparatus avoids choking of the screen, and processing efficiency is accordingly promoted.

In FIG. 4 and FIG. 5, unraveled pulp fiber of needle-leaf tree is guided in a duct 74 as is in FIG. 1 by a fan. The outlet of the duct 74 is flared in order that the carried filament by windblow is spread over full width of band-shaped fiber mass as shown in FIG. 1. On the open end of the duct 74 is a screen 75, which travels and back along a guide rail 78 driven by a wheel 77 on the holder 76. To sweep the screen, hard haired brushes of wire, horsehair or nylon 79, 80, 81 and 82 are equipped on the both sides of duct outlet, and they rotate in the direction shown by an arrow or to the opposite direction according to the motions of the screen. That is to say, in FIG. 4, if the screen travels in one of the directions shown by a solid arrow, brushes also rotate in one of the directions shown by a solid arrow, and vice versa. Under the screen 75, there is an endless wire-netting 85 and it travels over a suction box 84 driven by a suction tube 83. And another conveyor endless wire-netting 86 is also equipped under the endless wire-netting 85, as is the case with an endless conveyor wire-netting 21 of FIG. 1. Reference numeral 87 is a suction box driven by a suction tube 88, and 89 is band-shaped fiber mass.

Windblown dispensed fiber in the duct 74 hits the screen 75 and is scattered through the meshes of it. Flocked mass of fiber remains in front of the screen, and is unraveled by periodic motions of the screen and the brushes 79, 80, 81 and 82 to be scattered also through meshes of the screen 75.

Scattered filament is sucked by the suction surface of an endless wire-netting 85, and as the endless wire-netting rotates, band-shaped fiber mass is formed in turn. Then it is taken on another endless conveyor wire-netting 86 to be sprayed by adhesives and then to be dried as is the case with FIG. 1.

Thus, this apparatus avoids choking of the screen, and manufactured nonwoven fabrics has no directivity.

In the arrangement shown in FIG. 6, bleached kraft-pulp of needle-leaf trees, unraveled as is the case with FIG. 1, is guided into a duct 90 by a fan. The outlet of the duct 90 is flared as in FIG. 5 in order that carried filament is spread over full width of band-shaped fiber mass. Under the open end of 90 is a inclined screen 91, of which angle is adjustable freely by means of fulcrum 92 and which is vibrated in the direction perpendicular to the flow of fiber mass. In front of the screen 91 are brushes 93, 94, 95, 96 and 97, installed on the holder-frame 98 of the screen so as that they rotate in the direction shown by the reference arrow in the Figure, making contact with the screen. These brushes should be of wire, horsehair or nylon.

On one side of the screen 91 is a flock reservoir 99, which collects residual fiber not unraveled, and again feeds it back to a hammer-mill by means of a suction tube 100. Arranged under the screen 91 is an endless wire-netting 103 that travels over a suction box 102 driven by a suction tube 101. Another endless conveyor wire-netting 104 is also installed partially in plane contact with a section of the wire net conveyor 103, corresponding to an endless conveyor wire-netting 21 of FIG. 1. Reference numeral 105 is a suction box driven by a suction tube 106, and 107 is band-shaped fiber mass.

Windblown dispensed fiber in the duct 90 hits the upper part of the inclined and vibrating screen 91, and a part of fiber mass passes the mesh at once. Any remaining part will traverse the screen 91 along the slope of it, being vibrated and unraveled by brush rolls 93, 94, 95, 96 and 97, and scattered downward. A flock reservoir collects fiber not unraveled, and again feeds same back to the hammer-mill by means of a suction tube 100.

Scattered filament is sucked by the suction surface of an endless wire-netting 103, and as the endless wire-netting travels, band-shaped fiber mass 107 is formed. Then it is taken on another endless conveyor wire-netting 104 to be sprayed by adhesives and then to be dried as is the case with FIG. 1.

In the equipment mentioned above, meshes of the screen are kept clean usually in spite of the nature and sorts of fiber being processed, and uniform band-shaped fiber mass is formed continuously, because meshes of a screen are not choked over a long period of operation. Furthermore, the scattering rate is controlled by adjusting the slope or angle of the screen 91.

In the arrangement shown in FIG. 7, bleached kraft-pulp of needle-leaf trees, unraveled as is the case with FIG. 1, is guided into a duct 108 by a fan. The outlet of the duct 108 is flared as is in FIG. 5 in order that the carried filament is spread over full width of band-shaped fiber mass. The screen 109 is arranged to be endless in the case, and travels to the counter-clockwise direction in the Figure. The open end of the duct 108 is positioned at the starting point of the effective surface of the screen 109. Near the open end of the duct 108 is installed a brush roll 110 over the screen 109, so as that it rotates making contact with the screen. At the end of the effective surface of the screen 109 is a flock reservoir 112 with a suction pipe 111. Under the screen 109 is an endless wire-netting 115 that travels over a suction box 114 driven by a suction tube 113. Another endless conveyor wire-netting 116 is also installed in the face of the wire-netting 115 under it, corresponding to an endless conveyor wire-netting 21 of FIG. 1. Reference numeral 117 is band-shaped fiber mass.

Windblown dispensed fiber in the duct 108 hits the screen 109, and as the screen travels, fiber is scattered through the mesh. As the effective surface of the screen 109 extends to the right from the outlet of the duct 108, the fiber is widely spread over the effective surface of the screen 109 as it travels. A brush roll 110 installed near the duct 108 promotes unraveling, so as to make the fiber scatter through the meshes. Any remaining fiber not unraveled travels with the screen 109, and is collected in the flock reservoir 112 to be fed back into a hammer-mill by means of a suction tube 111.

Scattered fiber is sucked by the suction surface of an endless wire-netting 115, and as the wire-netting travels, band-shaped fiber mass 117 is formed. Then it is taken on another endless conveyor wire-netting 116 to be sprayed by adhesives and then to be dried as is the case with FIG. 1.

In the apparatus mentioned above, as the remaining flock is removed completely, meshes of the screen are usually kept clean, which in turn produces uniform fabrics without any of periodic disturbances. Furthermore, thickness of the fabrics is controlled freely by adjusting the speed of the screen.

What is claimed is:

1. Apparatus for producing nonwoven fabric wherein the improvement comprises,

a duct (9, 38, 54, 74, 90 or 108) for blowing out unraveled fibers with air therethrough,

screen means (13, 50, 58, 75, 91 or 109) arranged at the open end of said duct for screening said fibers,

a first endless wire-netting means (18, 51, 67, 85, 103 or 115) disposed on the back side of said screen means opposite said duct for receiving fibers passed through said screen means to form a band-shaped fiber mass on a front side of the working surface of said first endless wire-netting means,

a first suction means (19, 52, 66, 84, 102 or 114) provided at the back side of the working surface in said first endless wire-netting means,

a second endless wire-netting means (21, 53, 68, 86, 104 or 116) arranged at the underside of said first endless wire-netting means and to which said band-shaped fiber mass is transferred,

a first adhesive sprayer (23) provided at the front side of said second endless wire-netting means for spraying adhesive on said band-shaped fiber mass,

a second suction means (26) provided at the back side of said second endless wire-netting means and opposite to said first adhesive sprayer,

a first dryer (28) provided at said second endless wire-netting means and adjacent to said first adhesive sprayer,

a third endless wire-netting means (29) arranged at the underside of the end of said second endless wire-netting means,

a second adhesive sprayer (32) provided at the front side of said third endless wire-netting means for spraying adhesive on said band-shaped fiber mass,

a third suction section means (31) provided at the back side of said third endless wire-netting means and opposite to said second adhesive sprayer,

a fourth endless wire-netting means (33) arranged at the underside of the end of said third endless wire-netting means and,

a second dryer (36) provided at said fourth endless wire-netting means for drying said band-shaped fiber mass.

2. Apparatus for producing nonwoven fabric according to claim 1, in which said duct (38) is upwardly inclined, further comprising a rotatable hollow wire roll (39) which comprises coiled wires being mounted in the interior of said duct, first brush rolls (40, 40) for scraping out the flocks on said wire roll arranged at the side of said wire roll so as to be in contact therewith, a first suction piping (42) being opened at the back side of said first brush rolls, a second rotatable hollow basket-shaped brush roll (43) being mounted in the interior of said duct and above said wire roll, third brush rolls (45, 45) for scraping out the flocks on said second rotatable hollow basket-shaped brush roll being arranged at the side of said second rotatable hollow basket-shaped brush roll so as to be in contact therewith, a second suction piping (48) being opened at the back side of said third brush rolls, said screen means (50) being arranged at an arc-shaped opening in the end of said duct and extending along the front face of said second rotatable hollow basket-shaped brush roll, and said first endless wire-netting means (51) being arranged at the upper side of said screen means.

3. Apparatus for producing nonwoven fabric according to claim 1, in which said duct (54) has a downwardly facing outlet opening (59), a basket-formed brush roll (57) at the end of said duct, said screen means (58) being arranged at said outlet opening of said duct and extending around the lower half part of said basket-formed brush roll, a plurality of bars (60, 61) disposed at the side of said outlet opening of said duct, a second screen means (63) mounted on said bars, a second rotatable brush roll (62) mounted on said second screen means between said bars, third brush rolls (71, 72) for scraping out the flocks on said second screen means mounted above said second screen means, a flock reservoir (64) disposed at the side of said second screen means, and said first endless wire-netting means (67) 67) being arranged on the lower side of the first said screen means and said second screen means.

4. Apparatus for producing nonwoven fabric according to claim 1, in which said duct (74) has an outlet opening downwardly, said screen means (75) being reciprocally arranged under said outlet opening of said duct, a plurality of rotary brushes (79, 80, 81, 82) mounted on said screen means so as to rotate in the opposite directions according to the reciprocation of said screen means, and said first endless wire-netting means (85) being arranged on the lower side of said screen means.

5. Apparatus for producing nonwoven fabric according to claim 1, in which said duct (90) has an outlet opening downwardly, said screen means (91) being arranged in an inclined disposition under said outlet opening of said duct, fulcrum means (92) to adjust the angle of inclination of said screen means, means to vibrate said screen means in a direction perpendicular to the flow of fibers, said outlet opening of said duct being positioned at the upper end of said screen means, a plurality of brushes (93, 94, 95, 96, 97) mounted on said screen means so as to rotate in contact therewith, and said first endless wire-netting means (103) being arranged on the lower side of said screen means.

6. Apparatus for producing nonwoven fabric according to claim 1, in which said duct (108) has an outlet opening downwardly, said screen means (109) being arranged in an endless configuration, said outlet opening of said duct being positioned on the starting point of the effective surface of said screen means, a brush roll (110) mounted on the effective surface and adjacent to said outlet opening of said duct so as to rotate in contact with said screen means, a flock reservoir (112) having a suction pipe (111) disposed on the end of said effective surface of said screen means, and said first endless wire-netting means (115) being arranged on the lower side of said screen means.

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