METHOD AND MEANS FOR PRODUCING MIXED FIBER SUSPENSIONS IN AIR AND FELTS THEREFROM
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The present invention relates to felting fibers from air suspension and in particular to converting two or more supplies of fibrous material into a mixture of their individualized fibers in air suspension.

The present application is a continuation-in-part of my earlier applications Serial No. 276,150, filed March 12, 1952, now abandoned, and Serial No. 387,013, filed October 19, 1953 now Patent No. 2,926,417.

In general, there are two types of fibers classified according to length. These are so-called textile fibers and non-textile fibers. Textile fibers are those of natural or synthetic origin having lengths which enable them to be spun into threads having useful strength without added binder or adhesive in the thread. The non-textile fibers are commonly much shorter, such as the ultimate fibers of nearly all woods. In general, the authorities give a length of 5.08 mm. (2 inch) as the lower limit of length for making economically useful spun threads (see Matthews Textile Fibers, 1947 ed., page 27). There are a few wood fibers having lengths in the range from 5 to 7 mm. as follows:

Grand fir........................................ 5.0
Douglas fir........................................ 5.0
Western larch.................................. 5.0
Southern yellow pines......................... 4 to 6
Sierra spruce................................... 5.5
Bald cypress................................... 6.0
Redwood......................................... 7.0

These as well as all the shorter fibers of wood are not economically spinable.

The present invention is not necessarily concerned with the relative lengths of fibers, but its advantages become more apparent by choosing relatively long and short fibers to illustrate the invention.

Long or textile fibers in mass form, such as baled cotton, cotton waste, other mill wastes, rags and the like, are most easily and conventionally dispersed in individualized form by use of toothed devices such as cards, picker-rolls or lickerin rolls, which comb the fibers from their mutual association into looser and more dispersed form and in oriented positions. It is well known to use a toothed roll for such purposes to gather textile fibers onto its toothed periphery and then to dispense the fibers therefrom by a stream of air, thereby forming a suspension which may be air-laid as a felt in a variety of ways. Such processes are represented by U.S. patents to Burese No. 2,451,915 and to Phillips et al. 2,648,876.

Short fibers such as those derived from wood as commonly used in paper, cotton linters, and certain mill wastes of synthetic fibers, are easily individualized and dispersed into air streams by hammer mills and other mechanical dispersers, such for example as in my U.S. Patent No. 2,646,381. Thus, where it is desired to form an air-laid felt of mixed fibers, it is most feasible and economical to dispense the textile fibers into air by the air-doffing procedure and to dispose the shorter fibers into air by mechanical disintegrators or dispersers as described.

The present invention has for its object to doff fibers from a combing device by an air stream containing dispersed fibers for mixing the doffed and the doffing fibers in a common vehicle of air.

The invention is not limited to any particular kind of fiber to be doffed or to be dispersed in the doffing air stream as will appear from the following description and explanation of the invention given in connection with the accompanying drawings in which:

FIG. 1 represents diagrammatically a felting cylinder on which an air dispersion of fibers is felted, and three lickerin rolls for combing three supplies of fibrous material for air-doffing, at least two of the rolls being doffed by air containing suspended fibers, and all being doffed by the same stream of air.

FIG. 2 is a diagrammatic illustration of a single lickerin roll suitable to individualize long fibers by combing and by doffing from the comb teeth with an air stream.

FIG. 3 is a general representation of means for dispersing and individualizing short fibers into an air stream.

FIG. 4 represents a gravity settling chamber in which an air dispersion of mixed fibers is introduced, the mixing being accomplished by placing in series a disperser such as in FIG. 3 and a combing means such as in FIG. 2, to utilize the stream of air containing short fibers as means to doff the long fibers from the combing teeth.

FIG. 5 is a plan view of a gravity settling chamber similar to that of FIG. 4 showing a horizontal bank of independent nozzles, including two for short fibers alone and two for mixed short and long fibers.

It is to be understood that various modifications and departures from the foregoing illustrations may be made without departing from the invention hereinafter claimed.

In FIG. 1 there is a felting cylinder 10 of the type known as a condenser having a peripheral screen 11 on which fibers are felted from an air stream 12 traveling in conduit 13 and directed onto and then through the screen 11. Within the condenser is an extension 14 of the conduit 13 and in line therewith on the exterior a further extension conduit 15 leading to a suction inlet of blower 16. Conduit 13 leads from a lickerin roll 17 set to comb fibers from a supply such as a web or sheet 18 gradually fed to it on a shelf or bed 19 under a positioning roll 20. The lickerin roll turns counter-clockwise in FIG. 1 and its teeth 21 point generally in the direction of rotation so that the teeth with combed fibers reach the lowermost position in a narrow air passage or throat 22, air passing at high velocity in the direction of rotation and tangentially to the roll carries the fibers away from the teeth thereby dispersing them into the air stream. The conduit 13 is sufficiently long to allow the stream to expand and mix, and to distend the dispersion for felting as described.

To the extent described, the apparatus is similar to that illustrated in Burese U.S. No. 2,451,915.

According to the present invention, the air which passes through the throat 22 is already supplied with felted fibers dispersed therein. As a result, the impact of the dispersed fibers on fibers to be doffed from the lickerin roll 17 aids in doffing them, permitting considerable reduction in the velocity of air otherwise needed. Various methods and means may be employed to provide an air suspension of felted fibers and to utilize escaping fibers from the condenser 10 in the outlet 26 of the blower 16. The fines may be powdered material, dust, or unfelted and non-felted short fibers which have passed through the felt and screen.
The air in conduit 25 may contain any suspended material which it is desired to incorporate in the felt, for example, fibers. Suspension of a hopper containing powdered binder such as thermosetting resin 28 fed therefrom at a constant rate by a feed screw 29 into the conduit 15. Therein it is dispersed by the blower 16 into the air stream in conduit 25. Conduit 25 leads to a lickerin roll 30, like roll 17, with its teeth 31 likewise directed and positioned to receive fibers from supplied fibrous material 32 under positioning roll 33. The lowermost portion of the roll 30 resides in thrust 34 to which conduit 25 supplies air or water with content such as the binder 28. The combed fibers are deflected to form suspension 35 to channel 36. Channel 36 leads to throttle 37 at a like lickerin roll 38 which combs fibers from supply 39 under positioning roll 40.

This forms a new suspension 41 containing fibers from supplies 32 and 39 in channel 42. Channel 42 leads to the throttle 22 forming the said suspension 13 in conduit 13.

The fiber supplies 32, 39 and 16 may be identical materials or different. When different, a uniform mixture of the different fibers is obtained in the proportions desired and effected in one way by the speed of the lickerin roll relative to the rate of feed of the fiber supply. However, the advantages of the invention as illustrated in FIG. 1 are not only in mixing and doffing fibers. When the fibers are the same, the capacity of the apparatus for production is increased by use of a plurality of stations, the capacity of the felting cylinder being much greater than the capacity of a single lickerin roll to provide fibers for felting.

Compared to the speed and high capacity of mechanically dispersing short fibers into air, the combing and doffing to textile fibers is relatively slow and low in capacity. By use of a common air stream to doff the three lickerin rolls in FIG. 1, the capacity is trebled, permitting greater speed for the condenser 10 or otherwise thicker felts F formed therein.

The invention is not limited to felting on a condenser as shown in FIG. 1, nor to dry felting operations. The fibers suspension may be felted otherwise, as by gravity deposition irrespective of the kinds of fibers in the suspension or whether or not there is a mixture of fibers. However, the invention is of great value to add one kind of fiber to a suspension used in established felting methods. As an example, the gravity felting of fibers moistened with liquid adhesive is an established practice as exemplified by Brownell U.S. No. 2,493,194, Heritage No. 2,544,019 and Duvall U.S. No. 2,646,381.

Cick off high speed carding machines, the rate of formation in the gravity deposition process is slow. For high quality there are limitations. Dry vegetable fibers are never straight and rigid, especially those of wood, and they tend to flock. When present in the chamber as flocks the adhesive strikes only the surface of the flocks and not the interior, and the mat is lumpy and unbound where such flocks deposit.

The longer the fibers, the more they tend to flock and the less easy the flocks are disintegrated. The more concentrated the fibers are in air-suspension, the more they are inclined to flock, and this is accentuated by contact and friction with side walls of conduits, which slow the contacting fibers so that they catch faster passing fibers.

For all these reasons there are limitations to the rate at which fibers in air-suspension may be introduced into a settling chamber along with liquid adhesive. The disadvantages of greater length have made it impracticable to make fibers having long fibers with material having short fibers, for dispersing in air from the mixed materials a mixture of individualized long and short fibers.

One of the advantageous ways to maintain a dispersion of substantially individualized fibers has been to disperse the fibers directed into a moving air stream, and by causing the resulting dispersion at high velocity through limited distances by use of conduits which minimize flocking contact.

The tearing action of high velocity is effective to break up undesired flocks, and the shorter the fibers the more easily this occurs. Textile fibers that are not readily individualized in this way while wood fiber lengths of fiber are easily unflocked. In so dispersing short fibers into an air stream from a mass of short-fibered material perforated plates are used of hole-size accommodated to the length of fiber. In such practice, it is therefore not possible to have pressure fibers. The present invention aims to maintain the established economical relatively rapid procedure for forming an air-suspension of short fibers, and to introduce into it, just before use, individualized long fibers, preferably as a suspension of long fibers which are to be interfelted with the short fibers.

For the purposes of the present invention, the long fibers also must be provided or suspended in substantially individualized condition. There are problems in effecting this condition with such material. The dispersion should be formed late in the process so as to avoid long-distance conveyance of the suspension. Also, the material supplying the long fibers must be combed or carded mechanically to individualize the fibers, as by laying them stretched in a common direction, and then picking them off individually for dispersion in air.

The present invention uses a vehicular current of air containing the short fibers of the apparatus for soick off the combed or carded fibers. A high velocity stream is used to enhance the physical separation of the suspended fibers whereby flocking is minimized or prevented. Low concentration is thus effected. The dispersion of the long fibers may be effected in a suitable air dispersion of short feltable fibers, with or without a dry adhesive, so that the mixed fibers and adhesive may be uniformly mixed and the uniform mixture then felted, as by differential pressure on a filter, or by settling onto a collector or moving conveyor.

Where the adhesive is fluid, such as an aqueous starch solution as a fine mist or spray, its admixture with the fibers is preferably effected in air having a low concentration of suspended fibers, as is the case in a gravity deposition chamber. Otherwise, the liquid adhesive dispersion should be mixed with the fibers close to the mechanism to avoid wetting conduit walls to collect wetted fibers.

Where the adhesive is dry, as for example being a powdered pitch or asphalt, or thermosetting resin, it may be present in the dispersing air even before the fibers are introduced. Thus, it may be present in the air used to pick off the fibers.
is fed with a supply of air and fibrous material, this being introduced preferably axially of the casing 60 by the conduit 63. An annular portion of the casing is formed as a perforated plate 65 of which the perforations have a size accommodated to the length and diameter of fibers to be dispersed. The hammers 62 move slowly for feeding air into the casing 60 above the plate 65 thereby to rub the fibrous material to individualized fibers. The air passing into the casing from conduit 63 moves through the perforated plate 65 carrying the individualized fibers with it. A crescent shaped collecting hood 66 covers the plate 65 and converges the collected dispersion to a converging conduit 67. This corresponds to conduit 13 in FIG. 1.

It is, therefore, to be understood that the conduit 67 may join the conduit 56 of FIG. 2 to form a mixed dispersion in conduit 58, which is then carried to a feltering device. But as herefore stated it is disadvantageous to carry a mixture of long and short fibers over a long distance because of the tendency to clot or flocculate. This is especially true when liquid adhesive is to be applied. Hence, the mixed dispersion once formed is preferably conveyed only over short distances. FIG. 4 represents a conventional gravity settling chamber 70 in which there is a continuously moving conveyor 71 on which fiber settles by gravity and builds up a felt 72. The fiber dispersion for such felt is introduced by a nozzle 73 near the top and at the rear of the chamber 70. Liquid spray nozzles 74 and 75 are shown in the vicinity of the nozzle 73 for introducing a spray of liquid adhesive, such as a starch sol, or a thermosetting resin solution. Hence the fibers indicated by numeral 76 as settling in the chamber become wet with adhesive and form a moist mat 72. The moist mat so formed by gravity has a very low density and usually lacks sufficient strength to be self-sustaining.

The greater the content of long fibers, the greater the strength especially at this point. However, when compressed it has greater strength. Numeral 78 indicates a compression roll which reduces the thickness of the mat 72 to form a denser mat 79, shown as having sufficient strength to permit it to be transferred from the forming conveyor 71 to a second continuous conveyor 80, across a gap indicated at 81 in which if desired suitable transfer mechanism 82 may be placed. A suitable transfer device is shown in Heino U.S. No. 2,493,194. The conveyor 80 carries the compressed mat 79 into an oven 83 wherein it is dried and bonded according to the kind of adhesive employed.

The nozzle 73 above described may be one of a plurality of the same arranged in a horizontal bank, according to the width of the chamber 70. The nozzle 73 corresponds to the conduit 58 of FIG. 2, being an extension of a device similar to that of FIG. 2 and having the conduit 56 for introducing doffing air. As shown the conduit 56 is identical with conduit 67 of apparatus similar to that in FIG. 3. As a result, short-fibered material in conduit 63 is dispersed and individualized into a stream in conduit 67 and this dispersion is used to doff long fibers from the picker-roll 50 which derives them from the textile material 52.

FIG. 5 represents a form of apparatus, primarily intended for felting short fibers, but modified in one or more of its operation nozzles to air-doff long fibers into and by the suspension of short fibers. The felting chamber 90 is similar to that of FIG. 4 but shown in plan view. This view is shown to illustrate a horizontal bank of injection nozzles, which may be varied.

The outside ones are the dispensers of FIG. 3, presenting nozzles 67. The two inside ones are the combination of FIG. 4, presenting nozzles 58, having picker-rolls under casings 50 for fiber supplies 52, and air-doffed by suspension from the dispensers of FIG. 3. These nozzles may be suitably arranged so that in discharging into the chamber 90 their respective contents suitably mix to form a substantially uniform mixture of the two fibers before deposition as a mat. The numerals 91 indicate liquid spray nozzles to provide bonding material. It is to be understood that these nozzles need not be employed, as when no bond is desired, or when solid heat-activatable bond is introduced.

A wide variety of felts may be made by the present invention economically, and with a high rate of production. The invention may be carried out in various ways other than those chosen to illustrate the invention, and such changes and modifications are contemplated as falling within the scope of the appended claims.

1. The method which comprises combing and individualizing textile fibers from a supply of fibrous material, carrying the combed fibers away from said supply on a comb-toothed member, and doffing the fibers from said member into a confined channel by a passing stream of air containing suspended fibers dissimilar to textile fibers and comprising feltable wood fibers, said stream moving in said channel toward and past said member, thereby mixing doffed and doffing fibers in said stream in said channel.

2. The method which comprises combing and individualizing textile fibers from a supply of fibrous material, carrying the combed fibers away from said supply on a comb-toothed member, doffing the fibers from said member into a confined channel by a passing stream of air containing suspended fibers dissimilar to textile fibers and comprising feltable wood fibers, said stream moving in said channel toward and past said member, thereby mixing doffed and doffing fibers in said stream in said channel.

3. The method which comprises combing and individualizing textile fibers from a supply of fibrous material, carrying the combed fibers away from said supply on a comb-toothed member, doffing the fibers from said member into a confined channel by a passing stream of air containing suspended fibers dissimilar to textile fibers and comprising feltable wood fibers, said stream moving in said channel toward and past said member, thereby mixing doffed and doffing fibers in said stream in said channel, and converting the mixed fibers into a felt.

4. The method which comprises combing and individualizing textile fibers from a supply of fibrous material, carrying the combed fibers away from said supply on a comb-toothed member, doffing the fibers from said member into a confined channel by a passing stream of air containing finely divided solid binder and suspended fibers dissimilar to textile fibers and comprising feltable wood fibers, said stream moving in said channel toward and past said member, thereby mixing doffed and doffing fibers in said stream in said channel, and converting the mixed fibers and binder into a felt.

5. The method which comprises combing and individualizing feltable fibers from a first supply of fibrous material, carrying the combed fibers away from said first supply on a comb-toothed member, doffing the fibers from said second supply to a second member into a confined channel by a passing stream of air in said channel and thereby forming in said channel a first suspension of feltable fibers in air, and doffing the fibers from said second comb-toothed member into said channel by said stream of said first suspension moving in said channel toward and past said second member, thereby forming in said channel a second suspension of mixed feltable fibers.

6. The method which comprises combing and individualizing feltable fibers from a first supply of fibrous material, carrying the combed fibers away from said first supply on a comb-toothed member, combing and individualizing feltable fibers from a second supply of fibrous material, carrying the combed fibers from said
second supply away therefrom on a second comb-toothed member, doffing the fibers from the first member into a confined channel by a passing stream of air in said channel and thereby forming in said channel a first suspension of feltable fibers in air, doffing fibers from said second comb-toothed member into said channel by said stream of said first suspension moving in said channel toward and past said second member, thereby forming in said channel a second suspension of mixed feltable fibers, and converting said mixed fibers to a felt.

7. The method which comprises combing and individualizing feltable fibers from a first supply of fibrous material, carrying the combed fibers away from said first supply on a first comb-toothed member, combing and individualizing feltable fibers from a second and like supply of fibrous material, carrying the combed fibers from said second supply away therefrom on a second comb-toothed member, doffing the fibers from the first member into a confined channel by a passing stream of air in said channel and thereby forming in said channel a first suspension of feltable fibers in air, and doffing fibers from said second comb-toothed member into said channel by said stream of said first suspension moving in said channel toward and past said second member, thereby forming in said channel a first suspension of said feltable fibers.

8. The method which comprises combing and individualizing feltable fibers from a first supply of fibrous material, carrying the combed fibers away from said first supply on a first comb-toothed member, combing and individualizing feltable fibers from a second and like supply of fibrous material, carrying the combed fibers from said second supply away therefrom on a second comb-toothed member, doffing the fibers from the first member into a confined channel by a passing stream of air in said channel and thereby forming in said channel a first suspension of feltable fibers in air, doffing fibers from said second comb-toothed member into said channel by said stream of said first suspension moving in said channel toward and past said second member, thereby forming in said channel a richer suspension of said feltable fibers, and converting said suspended fibers to a felt.

9. The method which comprises combing and individualizing feltable fibers from a first supply of fibrous material, carrying the combed fibers away from said first supply on a first comb-toothed member, combing and individualizing feltable fibers from a second supply of fibrous material, carrying the combed fibers from said second supply away therefrom on a second comb-toothed member, doffing the fibers from the first member into a confined channel by a passing stream of air carrying suspended feltable fibers moving in said channel toward and past said second member, and thereby forming in said channel a second and richer suspension of feltable fibers in air, and doffing fibers from said second comb-toothed member into said channel by said stream of said second suspension moving in said channel toward and past said second member, thereby forming in said channel a third and still richer suspension of feltable fibers.

10. The method which comprises combing and individualizing feltable fibers from a plurality of supplies of fibrous material, carrying the combed fibers away from each supply by a separate comb-toothed member for each supply, and doffing the fibers from all of said members in series into a confined channel by a single stream of air containing suspended feltable fibers and moving in said channel toward and past each member of the series, whereby the last-doffed member of each pair of adjacent members in the series is doffed into said channel by a suspension of feltable fibers in said stream.

11. The method which comprises combing and individualizing feltable fibers from a plurality of supplies of fibrous material, carrying the combed fibers away from each supply by a separate comb-toothed member for each supply, and doffing the fibers from all of said members in series into a confined channel by a single stream of air containing suspended feltable fibers and moving in said channel toward and past each member of the series, whereby the last of each adjacent
two members in the series is doffed into said channel by
a stream of air containing fibers moving in said channel
toward and past each said last member.

References Cited in the file of this patent

UNITED STATES PATENTS

371,913  Archer  ---------------- Oct. 26, 1887
2,436,338  Smith et al.  -------------- Feb. 17, 1948

562,308  Great Britain  ------------- June 27, 1944

FOREIGN PATENTS

Great Britain  ------------- June 27, 1944