Sept. 12, 1967 M. MAYER, JR., ET AL 3,341,008

FIBER FRACTIONATING APPARATUS

Filed June 12, 1964 3 Sheets-Sheet 1

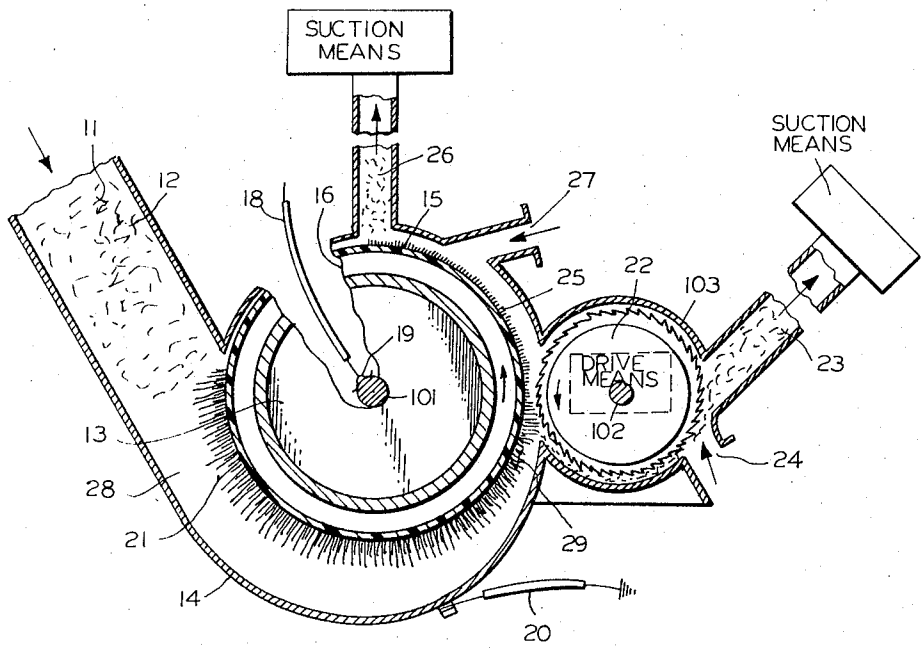


FIG. 1

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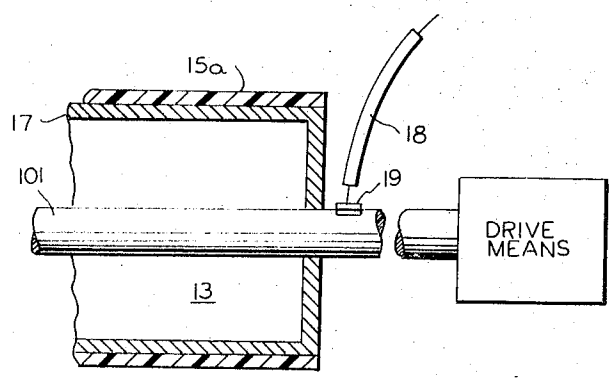


FIG. 4

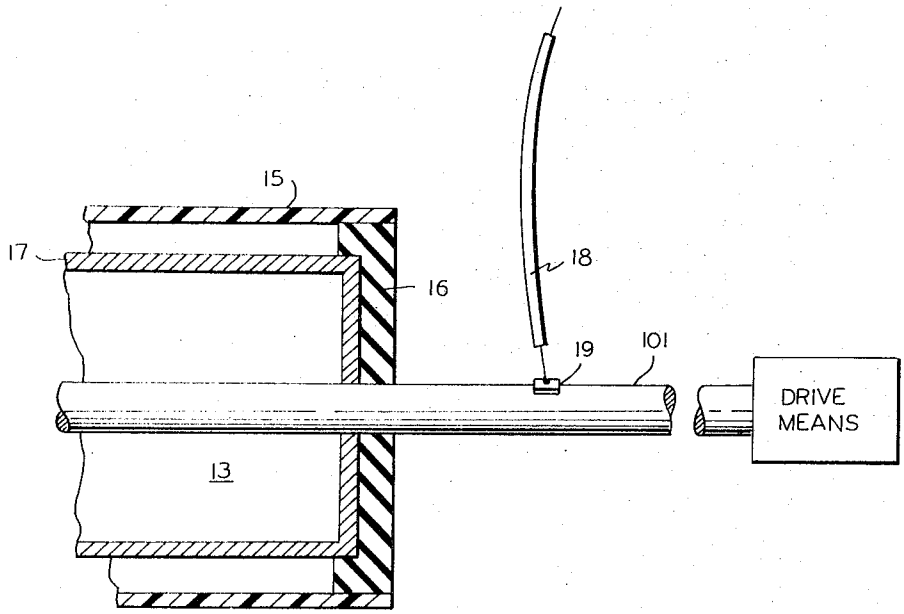


FIG. 2

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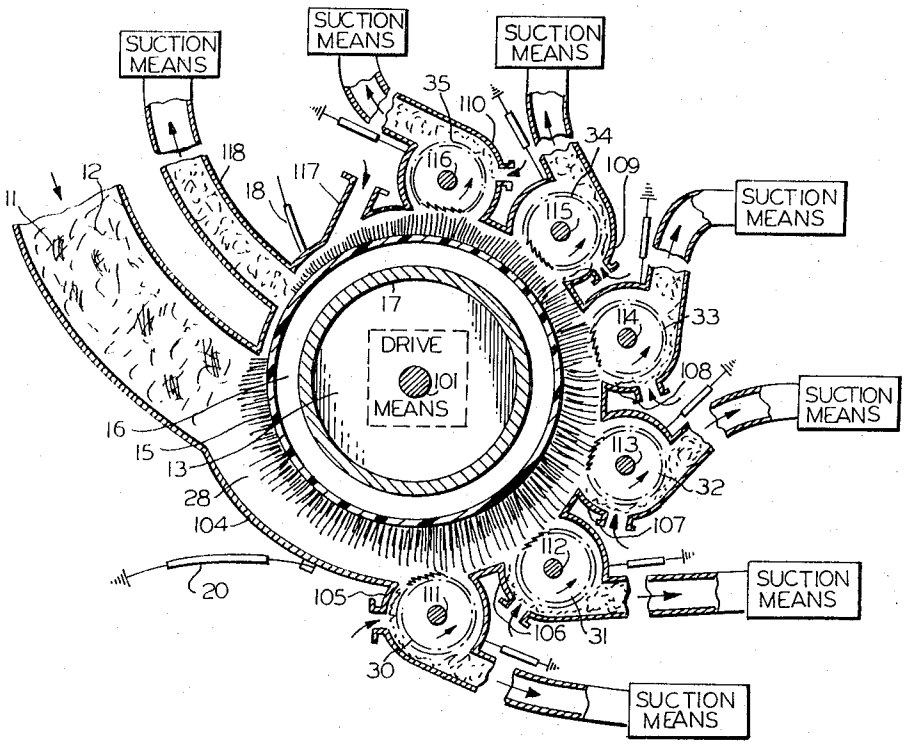


FIG. 3

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FIBER FRACTIONATING APPARATUS

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9 Claims. (Cl. 209—2)

A non-exclusive, irrevocable, royalty-free license in the invention herein described, throughout the world for all purposes of the United State Government, with the power to grant sublicenses for such purposes, is hereby granted to the Government of the United States of America.

This invention relates to an apparatus for fractionating fibers into length groups. More specifically, it relates to an apparatus for electrostatically aligning fibers and subsequently separating the aligned fibers into fractions having specific lengths.

Still more specifically, it relates to an apparatus for removing short fibers from cotton lint. Another object of our invention is to provide a novel process for determining fiber-length distribution.

As used herein, the term "fibers" relates to the individual components of cellulosic or noncellulosic materials such as cotton, rayon staple, nylon staple, vinyl staple, and the like. Because of its wide use, cotton will frequently be referred to below as "the fiber," but it is to be understood that this usage is illustrative only.

The term "lint" as used herein, relates to the full-length fiber, sometimes referred to below as "staple." The term "short fibers" relates to the shorter portions of the lint or staple, usually portions of fibers not longer than about three-eighths inch.

The presence of these short fibers has several disadvantages in the processing of lint cotton into yarn and/or fabric. In the first place, short fibers reduce the strength of the yarn. This results in a greater number of "ends down" or breakage during spinning thereby decreasing the efficiency of the process and increasing the cost. In the second place, these shorter fibers increase the total number of ends of fibers per unit length of the resulting yarn. These ends tend to protrude and impart a fuzzy character detrimental to the quality of the yarn. In the third place, yarns produced without these shorter fibers are characterized by their increased strength, their fineness, their evenness, their smoothness, their uniformity, and their commercial desirability.

In the past, these short fibers have been removed only by a low-capacity, costly, combining process. Because of the great expense involved generally, only fibers having a classer's staple length of at least about $1\frac{1}{16}$ inch, the more expensive of the cotton fibers, have been subjected to the combing operation. Therefore, it will be seen that prior to this invention there still remained a need for a practical means of eliminating the shorter fibers from lint. Such a means should be economically adaptable to the removal from lint of short fibers having a length of not more than $\frac{3}{8}$ inch. Last, but not least important, the means should not break or otherwise physically damage the fibers.

The apparatus which is the subject of our invention comprises any suitable means for uniformly introducing loose masses of relatively untangled partially individualized fibers into a fractionating chamber comprising an outer incurvate conductive electrode and a rotating, inner cylindrical electrode between which the fibers are further individualized and aligned. Both electrodes are electrically charged. Hence the fibers are rotatably conveyed to any appropriate doffing means such as one or more suitably surfaced rolls spaced from the charged cylinder a predetermined distance necessary for removing fibers of a length longer than that distance. For fractionating fibers into two length-groups; i.e., one with fibers longer than a predetermined length, e.g., about $\frac{3}{8}$ inch, and one with fibers shorter than that length, only one doffing roll is required. When n fractions of fibers are desired, $n-1$ additional doffing rolls are needed. Said roll or rolls, are spaced a distance equal to, or slightly less than, some predetermined fiber length. The longer fibers are removed by the specially surfaced doffing roll, from which doffing roll they may be removed for further processing by any suitable means, such as suction air. The short fraction of fibers which remains on the charged roll can be removed later for subsequent processing, or disposal, by suitable means, such as suction air.

One, but not necessarily the only, embodiment of an apparatus suitable for the practice of of this invention is described in the accompanying drawings in which:

FIGURE 1 is a sectional view showing the essential features of the invention.

FIGURE 2 is a sectional view showing details of the charged roll assembly.

FIGURE 3 is a sectional view showing details of another embodiment of this invention.

FIGURE 4 is a sectional view, similar to FIGURE 2, showing details of a modification of the charged roll assembly described below.

Referring to FIGURE 1, loose masses of disoriented fibers **11** are supplied by any suitable means, although positive air is preferred, through duct **12** into chamber **28**. This chamber is bounded on one side by the rotating, charged-roll assembly **13** and on another side by electrode **14**, the incurvate portion of duct **12**. When an electric current is passed between these electrodes, an electrostatic field is produced in chamber **28**. Charged roll assembly **13** (FIGURE 2) comprises outer cylinder **15**, spacer ring **16**, and electrode **17**. Cylinder **15** may be constructed of any conductive or nonconductive material. However, for reasons of convenience and efficiency, we prefer to use a nonconductive material, such as polyvinyl chloride, nylon, Bakelite, Pyrex glass, and the like. Electrode **17** is a conductive material secured to shaft **101** within and concentric with cylinder **15**. If a conductive outer cylinder is preferred, construction may be modified to utilize a simple conductive cylinder **17** in substitution for assembly **13**, thus making **15** and **16** unnecessary. Electrode **17** may be any desired distance from cylinder **15**, or it may be in intimate contact. This modification is shown in FIGURE 4, wherein the nonconductive cylinder, designated **15***a*, is in intimate contact with electrode **17**. We prefer to space cylinder **15** from electrode **17** by an insulator ring **16**, although satisfactory results are obtained when electrode **17** (e.g., tinplate) is fitted snugly against the inner surface of outer cylinder **15**.

As noted above, electrode **14**, FIGURE 1, is incurvate relative to charged roll assembly **13**. The distance between the electrodes is at a maximum in the region where the fibers first enter the electrostatic field and uniformly decreases as the electrode approaches doffer **22**. As a result, the potential gradient of the electrostatic field is at

a minimum when the fibers first enter chamber 28 and increases to a maximum at about 29.

Electrode 17 is energized through conductor 18, which is connected to the electrode through slide wire contact 19 on shaft 101, and electrode 14 is energized through conductor 20. An electrostatic field is produced between electrodes 14 and 17 using alternating current or preferably a direct current produced by any means common to the art. Although the successful operation of this invention is not so limited, we prefer to have electrode 14 connected to ground.

Fibers fed into duct 12 by any suitable external means at a uniform rate, such as positive air or feed roller (not shown) are conveyed into the chamber and into the region of electrostatic field in chamber 28 produced by charged roll assembly 13 and electrode 14. The effect of this field is to cause the fibers to become aligned parallel to the lines of force between electrodes 14 and 17. Charged roll assembly 13 is rotatably mounted in conventional bearings and driven in any conventional manner, such as a motor, pulleys, chain, belt, etc. These conventional means are shown schematically in FIGURES 2 and 4 by a box designated "DRIVE MEANS." As a result of the incurvate contour of the electrode 14 with reference to charged roll assembly 13, a uniformly increasing electrostatic field gradient is produced in the direction of rotation of assembly 13. The increasing field gradient causes the aligned fibers to migrate to the zone of higher field gradient 29.

The radially aligned fibers 21 are carried on cylinder 15 to a suitable doffing means, such as a toothed doffer roll 22, secured to shaft 102. As can readily be seen from FIGURE 1, doffer 22 is enclosed in a housing 103 which is an extension of electrode 14. Doffer roll 22 may be surfaced with any desired covering besides the toothed surfaces; i.e., the covering may be a velvet cloth, walrus hide, card clothing, or a pressure sensitive adhesive. Doffer 22 is rotatably mounted in bearings (not shown) and is driven by any conventional means shown schematically in FIGURE 1 by a broken line box designated "DRIVE MEANS." Doffer 22 is spaced from cylinder 15 by a distance sufficient to remove all fibers longer than a predetermined length while permitting all fibers shorter than the predetermined length to remain on cylinder 15. The fraction of longer fibers removed by doffer 22 is removed for subsequent processing, by any means common to the are such as suction air through duct 23 induced through opening 24. This conventional means is shown schematically in FIGURE 1 by a box designated "SUCTION MEANS," connected to duct 23. Doffer roll 22 also may be rotatably mounted in readily removable bearings (not shown) so that it may be easily removed and weighed before and after operation to determine the weight of the fibers in the length group which is removed.

The shorter fraction of fibers 25, FIGURE 1, remaining on rotating cylinder 15 is then removed through duct 26 by a second suitable doffing means such as suction air induced through opening 27.

As noted above, FIGURE 3 is a schematic view of another embodiment of our invention. In this embodiment, there is shown a modified arrangement which is similar in operation to the preferred embodiment discussed above. For this purpose, incurvate electrode 14 is modified to provide an incurvate electrode 104 having a plurality of extensions, such as housings 105, 106, 107, 108, 109, and 110, to provide for doffer dolls 30, 31, 32, 33, 34, and 35, respectively. Charged roll assembly 13 is the same as shown in FIGURE 1 and is rotatably mounted as already described. Doffers 30 to 35 are secured to shafts 111 to 116, respectively, each of the latter being rotatably mounted on conventional bearings (not shown). Fibers are fed into the region of electrostatic field in chamber 28 and aligned. The fiber fractions are removed in a like manner; however, any number of doffers may be used to fractionate the fibers into as many fractions as desired and

into any desired length groups. Doffer rolls 30, 31, 32, 33, 34, and 35 are spaced from a maximum to a minimum distance to remove decreasing-length fractions of fibers. Again the fiber fractions are removed from the doffers by suction air which is fed into the doffer housings as noted above. As in the case of the embodiment shown in FIGURE 1, the smallest fibers can be removed directly from roller 15 through duct 118 by means of any conventional suction device which will induce air into the interior of the apparatus through opening 117. Incurvate electrode 104 is segmented, i.e., physically interrupted by doffer rolls 30, 31, 32, 33, 34, and 35.

This embodiment of our invention is useful for determining fiber-length distribution of commercial samples of baled cotton, or for determining the possible breakage of the lint during the opening (of bales), cleaning (beating), picking, and carding operations, particularly the first three.

We claim:

1. Apparatus for fractionating a mass of disoriented textile fibers into different length groups comprising:
   (a) a rotatable first electrode;
   (b) a stationary second electrode insulated from and surrounding the rotatable electrode constituting a housing therefor and a fiber separating chamber, said stationary electrode having a outer wall incurvate in the direction of rotation of said rotatable electrode, said incurvate wall and rotatable electrode together defining a fiber separation zone of decreasing width in the direction of rotation;
   (c) means for rotating said rotatable electrode connected thereto;
   (d) inlet means connected to the stationary electrode at the point of maximum distance between the incurvate outer wall thereof and the rotatable electrode for introducing a mass of disoriented textile fibers into the chamber formed by the stationary electrode;
   (e) first outlet means connected to the stationary electrode at the point of minimum distance between the incurvate outer wall thereof and the rotatable electrode;
   (f) second outlet means connected to the stationary electrode at a point intermediate said inlet and first outlet means;
   (g) fiber doffing means mounted inside said second outlet means at a distance from the rotatable electrode predetermined to remove fibers of maximum average length from the disoriented mass;
   (h) means connected to said stationary and rotatable electrode for applying an electric charge thereto, thereby to produce an electrostatic field of increasing potential gradient in the fiber fractionating zone defined by the incurvate wall of the stationary electrode and the rotatable electrode, said potential gradient increasing in the direction of rotation of the rotatable electrode, whereby fibers introduced through the inlet means are caused to be aligned perpendicularly to the rotatable electrode;
   (i) first means connected to the fiber doffing means for removing long fibers from said doffing means; and
   (j) second means connected to the first outlet means for separately removing remaining shorter fibers through said first outlet means.

2. The apparatus of claim 1 wherein a plurality of fiber doffing means are mounted at progressively decreasing, predetermined distances from the rotating electrode thereby to separate the fibers into a plurality of length groups.

3. The apparatus of claim 2 wherein separate fiber removing means are connected to each of the doffing means.

4. The apparatus of claim 3 wherein the fiber removing means comprise separate air suction means connected to each of the fiber doffing means.

5. The apparatus of claim 1 wherein the rotatable electrode is an electrically conductive cylindrical member.

6. The apparatus of claim 1 wherein the rotatable electrod comprises an electrically conductive inner cylinder and a concentric nonconductive outer cylinder superimposed thereon.

7. The apparatus of claim 6 wherein the outer nonconductive cylinder is mounted directly on the surface of the inner cylinder.

8. The apparatus of claim 6 wherein an insulating spacer ring is mounted between the inner and outer cylinders to separate said cylinders.

9. The apparatus of claim 1 wherein the means for removing long fibers from the doffing means and for removing shorter fibers through the first outlet means are separate air suction means.

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