SAMPLES REMOVED

#1 (CONTROL) A PICKER LAP

#2 LICKER-IN BEFORE MOTE KNIVES

#3 AFTER MOTE KNIVES

#4 CARDING CYLINDER BEFORE GRANULAR SURFACES

#5 CARDING CYLINDER AFTER GRANULAR SURFACES

#6 DOFFER

#7 WEB AFTER DOFFER KNIFE

#8 SLIVER

FIG. 4

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ABSTRACT OF THE DISCLOSURE
An apparatus for obtaining samples of fibers held by the rapidly moving surfaces of textile carding machinery where the fibers are collected within a container having a perforated membrane positioned therein and having suction air means connected to the container. The forward compartment of the carding assembly is connected to a flexible hose having a demountable orifice. To avoid turbulence the container and the membrane are formed in various geometrical configurations.

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The invention relates to an apparatus for plucking fibers from rapidly moving machinery. More specifically, it relates to an apparatus for collecting samples of fibers from a carding assembly. Still more specifically, it relates to an apparatus for plucking samples of fibers at various points within the carding assembly during commercial production. Another object of this invention is to provide a novel process for plucking samples of fibers from the rapidly moving surfaces of a carding assembly while it is in commercial production.

As used herein, the term "fibers" relates to the individual components of cellulose or noncellulosic material 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 "moving machinery" or "rapidly moving machinery" as used herein relates to any moving or operating machinery employed in the manufacture of precursors of yarn from fibers. Because of its importance to the textile industry, the "carding assembly" will be discussed below but it is to be understood that this usage is illustrative.

The term "carding assembly," sometimes referred to as "the card," "the carding machine," or "the carding ensemble" as used herein relates to an assembly of different units which converts a layer of partially disoriented fibers or bunches of fibers such as cotton lint, or staple, into a rope, or sliver. During the conversion, the fibers arrive at one end of the carding assembly as a "lap," sometimes called a "picker-lap," and exit from the other end as a "sliver," or "yarn precursor." During the passage, one yard of lap may produce about 100 yards of sliver.

The objects of carding these masses of short fibers are many. In the first place, these masses or bunches of short fibers must be separated into individual fibers to produce a satisfactory yarn; in the second place, these bunches of fibers, particularly cotton fibers, contain some trash, dirt, motes, and short or broken pieces which must be removed; in the third place, any small bunches must be separated into their individual components or else re-moved from the exiting sliver; in the fourth place, as noted above, the thick entering lap of cotton must be extended to form a fluffy rope or sliver which is the precursor of cotton yarn; and, in the fifth place, the individual fibers must be partially straightened, or aligned, in a parallel position during the carding operation.

In order to accomplish the above objects, the carding assembly comprises a series of integrated parts including, among others, a feed roll, a picker-in, a carding cylinder, granular or flat cards, doffer roll, doffer knife, crush rolls, etc. The surfaces of most of these parts move at a high rate of speed, e.g., 1000 to 4000 feet per minute. Further, the surfaces of most of these parts are covered with wire teeth.

During the passage of the fibrous lap through this assembly, the fibers are first plucked by the wire teeth of the picker-in from the lap. This is accomplished by the wire teeth contacting the fibers, that are part of the fibers, near the center of the fiber length, the fiber then acquiring an U-shape around the wire tooth with the ends of the fiber flying out due to the centrifugal force resulting from the rotating cylinder. During this passage, the fibers must pass several transfer points, i.e., points at which they are transferred from one moving unit of the assembly to another unit. At each transfer point, the fiber is plucked from one moving part by a second moving part with possible physical damage occurring. Further, the individual fibers must be contacted near the center of their length before they can be transferred.

As these flying ends revolve on the picker-in, they collide with the mote-knives. The impact of this collision removes trash, sand, some motes, and some short fibers. This impact may also cause some surface damage. After passing the mote-knives, the fibers contact the wire teeth on the carding cylinder and, with the ends still flying out, are transferred onto this cylinder.

When the fibers are individualized at this point, they are carried on to the doffer cylinder. However, if the fibers are bunched, these bunches contact the granular, or wire surfaces, of the cards and the bunches are converted into individual fibers. Finally, these individualized fibers are carried by the carding cylinder and then carded to form the precursor of yarn.

Comparison of samples removed from the entering lap (control) and the exiting web, or sliver, have shown that physical damage has occurred to the surfaces of the fibers, especially cotton. However, because of the physical danger involved it has not been possible, heretofore, to obtain samples from the rapidly moving surfaces of the carding assembly to determine which step, or steps, has caused the surface damage.

A sample could be obtained at various points by stopping the carding ensemble which, as it coasts to a stop, still is passing fibers through the operation. However, these samples were unsatisfactory. In the first place, they were too small to permit satisfactory evaluation. In the second place, they were not representative of the physical forces of the assembly when it was traveling at normal speed. Further, stopping the machine reduced the output of sliver and increased the cost. Most serious, the uniformity of the yarn precursor resulting from stopping and starting the ensemble was affected. Therefore, prior to this invention, there remained a need for a satisfactory device for sampling fibers passing through the carding operation. Such a device should be reliable, accurate, and give a true picture of what happens during actual production. It should make possible sampling at various points in the assembly while the machine is in maximum motion. It should be capable of obtaining a sample sufficiently large to permit complete evaluation of possible physical damage to the surfaces of the fibers. Last, but not least, it
should be free of potential danger of physical injury to the operator who collects the sample. The apparatus which is the subject of this invention comprises a novel means for introducing loose masses of partly individualized fibers into a collecting chamber comprising a forward compartment and a rear compartment, the two being separated by a perforated membrane. The two compartments may be shaped to have uniformly parallel sides or they may be tapered so that the maximum width is at some intermediate point between the front and rear terminals. These terminals form external outlets, preferably circular, to which is attached a lip which serves as a connection to a flexible conduit. The wall of the front compartment contains a transparent window-door combination anterior to the perforated membrane to enable the operator to observe the size of the sample being collected and to recover the collected sample. Using suitable means, such as suction air, fibers may be plucked from various surfaces in the carding assembly while maintaining normal production speed, and collected in the front compartment of the novel sampling device while waste components pass through the perforated membrane into the second compartment.

It is an advantage of the apparatus of our invention that when a sample is being collected, all the fibers from the sampling area are removed from the moving surfaces. This was unexpected.

It is another advantage of our invention that a large sample may be collected without clogging of the perforated membrane. This also was unexpected.

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

FIGURE 1 is a plan view showing the essential features of a sampling apparatus in which the compartments are rectangular.

FIGURES 2 and 2A are plan views of another embodiment of this invention in which the compartments are conical.

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

FIGURE 4 is a diagrammatic view illustrating the passage of textile fibers through the carding assembly and suction conduits to the point at which samples were taken for analysis as discussed in the examples below.

Referring to FIGURE 1, samples of loose masses of partially disoriented staple fibers carried on the surfaces of rapidly moving machines are plucked from these surfaces through orifice 1 of first flexible conduit 2 which is secured to opening 3 of rectangular front compartment 11. The loose masses pass into and through flexible conduit 2 and into compartment 4 where the longer fibers are retained by perforated membrane 5 and the build-up of sample 6 is observed through transparent window-door combination 7 by means of which the sample is recovered. Dust and small fragments pass through perforated membrane 5 and out of the opening 13 of rectangular compartment 11 through second flexible conduit 10 into collecting basin 12, or are discharged into the air through suction-air source 14. When suction air is used as the means for plucking the staple fibers from the moving surfaces of the carding assembly, the source of suction air may be mounted independently from the compartments to reduce possible vibration of the collecting compartment.

Compartments 4 and 11 may be approximately equal in size, or different, and the size is determined by the location of perforated membrane 5, which may be secured to the compartments by means known to those skilled in the art. In this embodiment of our invention, the perforated membrane is transverse to the direction of air-and-fiber flow, and its position is fixed.

The source of suction air may be by any means known to those skilled in the art. However, the speed of flow of the suction air through orifice 1 is critical. In feet per minute, the speed of flow of the suction air through orifice 1 must be as great as, preferably about 50% greater than, the speed of the surface of the moving machine. For example, the speed of the surface of a carding cylinder may be as high as about 4000 feet per minute. Accordingly, for best results the speed of the air flow at orifice 1 must be at least 4000 feet per minute and we prefer speeds up to 6000 feet per minute. With a suction-air machine which maintains a constant "pull" under load, the speed of the air-flow through orifice 1 may be controlled by varying the size of orifice 1. A satisfactory size of the orifice is readily determined when the apparatus removes all the fibers from the particular moving surface. The shape of the orifice is not critical. It may be round, square, rectangular or elliptical. We prefer the elliptical shape with the length being from about three to about six times the width, the latter ranging from about 3/4 to 1 inch. A demountable orifice having a dimension of 3/8 x 2 inches is a good practice.

The flexible conduits may be rubber, synthetic plastic, or other flexible material. It is critical that the walls of the flexible conduits be sufficiently strong to resist collapsing from the vacuum caused by the suction air. Best results are obtained when the inside walls of orifice 1, first flexible conduit 2 and opening 3 are made of transparent material. First flexible conduit 2 may be attached to front compartment 4 through opening 3 by conventional means known to those skilled in the art.

The walls of the compartments may be of any rigid material, preferably light in weight, such as wood, aluminum, plastic, zinc-coated iron, etc., and should be strong enough to resist collapsing under operating conditions. The transparent window-door combination may be glass or transparent plastic, but we prefer nonbreakable material. As noted above, the window-door combination should be located just anterior to the perforated membrane 5 and should fit snugly against the wall of compartment 4 to prevent leakage of air during the collection of samples.

The perforated membrane may be metallic or any other suitable material which will maintain its rigidity and be strong enough to withstand the force of the impact of the air stream and the flow of fibers. Zinc coated steel wire, copper wire, aluminum wire, or fiber glass may be used. We prefer a nonstaining metallic wire such as monel or stainless steel.

The openings in the perforated membrane may range from about 10 to about 50 per linear inch, or about 100 to 2500 perforations (openings) per square inch. A stainless steel screen having a mesh of about 40 x 40 per inch is a good practice. Such a screen might have a wire diameter of about 0.0106 inch, or #30 wire. The area of the perforated membrane may correspond to the cross-sectional area of the compartments or it may be greater as will be discussed below. Rectangular screens having an area of about 20 square inches permit satisfactory samples to be collected. When larger samples of fibers are required, we prefer the use of a conical membrane discussed more fully below.

As noted above, FIGURES 2 and 2A are plan views of another embodiment of our invention generally similar in operation to the embodiment discussed above. In FIGURE 2, two conical compartments are separated by the perforated membrane which is also placed transverse to the direction of air and fiber flow. The bases of the two compartments are butted together against the perforated membrane and may be secured by flanges (not shown) or other means known to those skilled in the art. The two conical compartments are preferably positioned so that a straight line between the vertices is coincident, or nearly so, with the major axis of each of the cones. Each compartment has an opening at its vertex which is secured a flexible conduit. As so described, sides a and d of FIGURE 2 are equal in length; likewise sides b and

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c. The other numbers of FIGURE 2 have the same meaning as in FIGURE 1.

In FIGURE 2A the sides a and d are not equal in length and the perforated membrane is angularly displaced with respect to the direction of air and fiber flow. Such a structure may be described as two oblique-elliptical conical compartments butted together and preferably positioned so that a straight line between the two vertices lies within the enclosed area of the compartments. In this embodiment, sides a and c are preferably essentially parallel, the other numbers in FIGURE 2A have the same meaning as in FIGURE 1.

In the above embodiment where the length of sides a and d may be the same (FIGURE 2), or different (FIGURE 2A), the general position of the perforated membrane is also fixed.

The size and number of openings in the perforated membrane, the materials used for its construction, the requirements for the materials used in constructing the compartments, the flexible conduits, the window-door openings and inlet orifice 1 generally follow the requirements enumerated above. A good source of suction air also is required.

It is an advantage of this embodiment of the invention employing conical-shaped compartments that the gradual and smooth expansion of the compartment from the first flexible-conduit inlet 3 reduces possible turbulence of the air stream when high air speeds at orifice 1 are required to pluck fibers from rapidly moving surfaces such as the carding cylinder which, as noted above, may have a surface speed of 4000 feet/minute.

Referring to FIGURE 3, where the numbers have the same meaning as above, the two conical compartments 4 and 11 of the apparatus of FIGURE 2 are separated by the insertion of cylinder 8, said cylinder 8 having the same diameter as the base of the two conical compartments. The base of each compartment and both ends of cylinder 8 may be flared-out (not shown), the flared-out portions containing four drilled holes through which screws with wing-nuts may be inserted to secure the conical compartments to the cylinder.

Perforated membrane 5 in this embodiment of our invention is a rather rigid cone securely fastened to a flared-out base (not shown) said base having the same diameter as the base of conical compartment 11 so that the cone-shaped, perforated membrane may be secured between the base of compartment 11 and the end of cylinder 8 by the same winged nuts employed in attaching compartment 11 to cylinder 8. The conical, perforated membrane is preferably at least as long as cylinder 8. It is within the scope of our invention that this conical shaped perforated membrane may be longer than cylinder 8, and the apex may extend into the tapered portion of compartment 4, but not more than about one-fourth of the axial length of this tapered portion of compartment 4.

The edges of perforated membrane are joined, as by soldering, or other suitable means to form this rather rigid, conical structure.

The term "perforated cone" or "conically-shaped perforated membrane" as used herein includes perforated membranes shaped generally like an "obelisk," that is, having generally parallel or slightly sloping sides and capped with a smaller cone at the apex. The "obelisk-like structure" may be polygonal, smaller in diameter than compartment 11 and attached to a flared-out base as described above.

It is an advantage of this embodiment of this invention that higher air speeds may be passed through the apparatus without causing turbulence, as the perforated area is larger.

It is a further advantage that larger samples of fibers may be collected on this larger area.

It is a still further advantage that higher air speeds may be passed through the apparatus with the same source of suction air because of the larger perforated membrane.

It is a still further advantage that the perforated membrane may easily be removed from the apparatus to recover the collected samples of fibers.

As noted above, FIGURE 4 shows diagrammatically the steps in the passage of fibers through the carding assembly and the points at which samples were removed for evaluation as to possible surface damage. The loose masses of partially disoriented staple fibers in the form of lap (picker-lap) enter the carding assembly at point A, from which they are fed onto the picker-in B. This is Transfer Point Number 1. The picker-in carries the fibers to the carding cylinder by one of two routes. As noted above, the flying ends (cotton) may be slapped against mote-knives to remove some dirt, sand, motes and short fibers before they come in contact with the wire teeth of the carding cylinder C; or some fibers such as synthetic staple may pass directly to the carding cylinder without contact with mote-knives. However, passage from the picker-in to the carding cylinder is Transfer Point Number 2.

The carding cylinder then conveys the fibers to doffer E by one of two routes. Individualized fibers forming a U-shape around the wire teeth of the carding cylinder pass directly to the doffer "sliding" by the flats (granular tops) without difficulty. However, "bunches" of fibers can not slide through. They are grasped and held by the flats or granular surfaces (which are being used) and held, until the revolving carding cylinder in cooperation with these surfaces has combed out the bunches, thereby straightening the individual fibers after which they are passed on to doffer E. Here the fibers are removed from the carding cylinder. This is Transfer Point Number 3.

The straightened and nearly parallel fibers are then removed from the doffer roll E in the form of a light web F by doffer knife F. The resultant individualized fibers in straightened and partially parallel form may, or may not, pass through a pair of crush rolls prior to being formed into a fluffy rope H, described above as "sliver." Thus the precursor of yarn is formed and is collected on the coiler I.

As is well known in the yarn-spinning industry the carding assembly physically affects the yarn, especially cotton yarn. However, as noted above, prior to this invention, it has not been possible to determine at what point in the carding operation this physical effect occurs. Comparisons between the entering lap and the exiting web (or sliver) indicate that the surfaces of the fibers have been altered.

It is apparent that the above description and the following examples are given by way of illustrating a preferred embodiment of the invention, and the various structures are subject to wide variations without departing from its scope. Some variations were pointed out as the description progressed; others will be readily apparent to those skilled in the art.

Example 1

Samples of Acala cotton fibers which were being passed through a carding assembly equipped with granular surfaces were plucked by the apparatus of this invention from (1) the incoming lap, (2) the picker-in before contact with the mote-knives, (3) the pickin, (4) the carding cylinder before contact with the flats (granular surfaces), (5) carding cylinder after contact with the flats, (6) after transfer to the doffer cylinder, (7) from the web after the doffer knife, and (8) the sliver.

The above samples included Transfer Point Numbers 1 (from the picker-in to the picker-lap), Transfer Point Number 2 (from the picker-in to the carding cylinder), Transfer Point Number 3 (from the carding cylinder to the doffer). These various points are detailed in the flow sheet of FIGURE 4.

These samples of plucked fibers were then evaluated.
for surface damage according to the process of Marsh, P. B., Merola, G. V., and Simpson, M. E., Textile Research Journal 23, 831–841 (1953). The results follow:

1. There was no significant statistical difference between averages for:

(a) Before and after mote knives;
(b) Carding cylinder before and after contact with the flats;
(c) Between doffer and the web;
(d) Between the web and the sliver.

2. There was a significant statistical difference between:

(a) The lap and the licker-in, at >99%. (This is across Transfer Point Number 1.)
(b) Between the licker-in and the carding cylinder, >99%. (This is across Transfer Point Number 2.)
(c) Between the carding cylinder samples and the doffer samples. (This is across Transfer Point Number 3.)

It will be observed that there is no distinguishable difference between fibers plucked from the cylinder before and after the granular surfaces of the cards indicating that the actual carding of the bundles of fibers did not produce surface damage. This was unexpected as it has been the belief in industry that considerable damage occurred at this point.

It will also be observed that definite damage did occur at the three transfer points. Prior to this invention, this information could not be obtained.

Example 2

The procedure of Example 1 was repeated using, however, Delta Pine cotton instead of the Acala fibers of Example 1. Generally similar results were obtained.

We claim:

1. An apparatus for collecting samples of partially disoriented staple fibers from rapidly moving machinery which comprises:

(a) a compartmentized container having a forward compartment and a rear compartment, said compartments being separated by a perforated membrane;
(b) means for securing the perforated membrane between the two compartments;
(c) the wall of said forward compartment having two external openings, the first opening consisting of a transparent window-door combination situated adjacent to and anterior to the perforated membrane, the second opening opposite the perforated membrane, said second opening including means for the attachment of a first flexible conduit thereto;
(d) a first flexible conduit attached to said means, the anterior end of said first flexible conduit containing a demountable orifice, the inner walls of said demountable orifice, said first flexible conduit and said second-opening attachment forming a smooth, continuous surface;
(e) the wall of said rear compartment having an external opening situated opposite the perforated membrane and including means for the attachment of a second flexible conduit;
(f) a second flexible conduit attached to said means, the posterior end of said second flexible conduit including means for attachment to a source of suction air, whereby an air stream may be passed from said orifice into and through the perforated membrane.

2. The apparatus according to claim 1 wherein the perforated membrane is metallic and contains from about 100 to 2500 perforations per square inch of surface area.

3. The apparatus according to claim 1 wherein the perforated membrane is transverse to the direction of the air and fiber flow.

4. The apparatus according to claim 1 wherein the perforated membrane is angularly displaced to the direction of the air and fiber flow.

5. The apparatus according to claim 1 wherein the perforated membrane is conically shaped, its axis is in substantial alignment with the central axis of the forward and rear compartments and its vertex is positioned to meet the incoming air and fiber flow.

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