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3,550,214

METHOD OF FIBER TRANSFER
IN CARDING PROCESS
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2 Claims

ABSTRACT OF THE DISCLOSURE

Method of transferring the web of carded staple fibers from the carding cylinder to the doffer surface by rotating the doffer, which is mounted with metallic wire, at a position close to the circumference of the rotating carding cylinder which is carrying the web of carried and parallelled staple fibers, characterized in that the doffer is rotated at a surface speed greater than that of the carding cylinder, whereby transferring the web of staple fibers on the cylinder surface to the doffer surface, while carding the said staple fibers.

This is a continuation of application Ser. No. 755,183, filed Aug. 26, 1968, now abandoned.

This invention relates to an improvement in a transferring step in the carding process of staple fibers. More particularly, the invention relates to an improved method of transferring the web of carded and parallelled staple fibers from the rotating carding cylinder onto the doffer.

Conventionally, preceding the preparation of spun fiber from staple fibers, the staple fibers are subjected to carding process. That is, the procedure of opening the fiber mass, removing dust and short fibers, and parallelizing the fiber strands, by the carding action is normally performed by a machine called carding engine. In this carding process, the fiber lap is rolled back by a feed roller and supplied to the tip of a plate. Where the staple fibers are carded by the teeth of the carder which is mounted with metallic wire and which rotates at a speed of 200 to 1,500 r.p.m., and transferred to the rotating direction of the carder as caught on the teeth thereof. The staple fibers moving as caught on the teeth of the carder is further transferred onto the teeth of a carding cylinder coated with metallic wire, which is provided closely to the teeth in carder and is rotating at a surface speed greater than that of the carder. During the transfer, the staple fibers receive carding action caused by the difference in surface speeds of the above two members. Above the carding cylinder, endless flats coated with metallic wire on flexible card clothing are installed, which is located very close to the carding cylinder and moves at a speed considerably less than the surface speed of the carding cylinder. Also due to the difference between the speed of the flats and of the carding cylinder, the staple fibers receive the carding action and are parallelized. Then the web of carded and parallelled staple fibers on the carding cylinder is transferred onto the doffer coated with metallic wire, which is located closely to the carding cylinder and rotates at a less surface speed than that of the carding cylinder. The web of staple fibers on the doffer is subsequently peeled off the doffer by a vertically vibrating fly comb, bundled into sliver and collected into a can.

Thus, in the conventional carding process, the surface speed of the doffer is maintained at a considerably less value than that of the carding cylinder, such as a ratio of one to several tens. Consequently the staple fibers moving at a high speed as caught by the teeth on the carding cylinder are seized onto the working portion of the teeth of slowly moving doffer. Therefore the once carded and parallelled staple fibers on the carding cylinder receive an anticarding action, which results in partial undoing of the parallel state of the staple fibers, as well as the bending of rear portions of the staple fibers, the phenomenon normally referred to as "hook." Thus the conventional carding process fiber hooks are formed, which reduces the effective length of staple fibers and prevents the imparting of sufficient strength to the spun fibers. Means for completely solving the problem of end hooks in the fibers formed in the carding process has not yet been discovered. In the conventional spinning techniques, only a passive remedy is applied to this problem, i.e., the slivers with many end hooks formed in the carding process are subjected to odd number of treating steps between the carding and fine spinning procedures, for example, odd number of drawing and roving steps, so that the hooks would position at the end of the staple fibers in the rovings to be supplied to the draft roller of fine spinning machine. By such a device, however, the strength of spun fibers is improved over the case of employing even number of intermediate treatments between the carding and fine spinning procedures, only by 2-3%.

Accordingly, the object of the invention is to provide a method of transferring the web of staple fibers in the carding process, which will solve the problem of hook formation in the staple fibers during the conventional carding process.

Another object of the present invention is to provide a carding process and apparatus which can prepare the sliver of staple fibers containing substantially no hook, and in which the staple fibers are perfectly parallelized, by repetitive carding actions exerted in the carding process.

Still another object of the invention is to provide a process which can produce with high speed the sliver of carded staple fibers suited for the preparation of spun fibers of improved strength and reduced unevenness compared with known spun fibers.

According to the invention, the foregoing objects are accomplished by the method of transferring the web of carded staple fibers from the carding cylinder to the doffer surface by rotating the doffer, which is mounted with metallic wire, at a position close to the circumference of the rotating carding cylinder which is carrying the web of carded and parallelled staple fibers, characterized in that the doffer is rotated with a surface speed greater than that of the carding cylinder, whereby transferring the web of staple fibers on the cylinder surface to the doffer surface, while carding the said staple fibers.

For a better understanding of the invention, refer to the attached drawings.

FIG. 1 shows the arrangement of the cylinders in the carding engine used for conventional carding process.

FIG. 2 shows the arrangement of the cylinders in the carding engine useful for practicing the subject process.

FIGS. 3A, 3B and 3C are respectively the side view, cross-section and an enlarged side view of the metallic wire mounted on the roller comb which is used in practicing the subject invention.

An example of roller arrangement and surface speeds of the rollers in known carding system can be given as illustrated in FIG. 1 and Table 1 below.
Referring to FIG. 1, the fiber lap on the dish plate 1 is nipped between the dish plate 1 and the feed roller 2 rotating in the direction of the arrow, and the staple fibers drawn out from the lap are caught by the teeth of metallic wire on the take-in which is rotating clockwise, at the tip of the dish plate 1, to be transferred to the surface of the take-in. The surface speed ratio of the two members at this time is 1,380 times as indicated in Table 1, and due to this difference in surface speeds, the staple fibers are carded. The staple fibers on the take-in are then caught by the teeth of the metallic wire on the carding cylinder 4 which is located close to the circumference of the take-in, at the side opposite from the dish plate across the take-in, and are transferred onto the said cylinder to be carried to the rotating direction of the same cylinder (counterclockwise direction). The surface speed ratio of carding cylinder to the take-in is, for example, 2.28, as indicated in Table 1.

Above the carding cylinder and closely to the circumference thereof, endless flats 5 are provided. The staple fibers on the surface of the carding cylinder receive the repetitive carding action by the relative motions of the teeth on the flats and those on the carding cylinder. In that case, the surface speed ratio of the carding cylinder to the flats is in the order of 8,300, as indicated in Table 1. The greatest part of the carding given to the staple fibers is performed by the said relative actions of the flats and carding cylinder. Then, the carded and paralleled staple fibers on the carding cylinder are caught by the teeth of the doffer 6, which is located close to the circumference of the carding cylinder and at the opposite side from the take-in across the carding cylinder, and which is clockwise rotating. Thus, the fibers are transferred onto the doffer surface. In the conventional carding process, the surface speed ratio of the doffer to carding cylinder is invariably in the order of one to several tens. (According to Table 1, it is one to thirty-six.) Therefore, the staple fibers receive an anticarding action during the last-mentioned transfer, and consequently not only the hooks are formed at the end of the linearly paralleled staple fibers, but also the parallelism in the staple fibers is damaged.

The web of staple fibers thus transferred onto the doffer surface is separated from the doffer by a vertically vibrating fly comb 7 and bundled into sliver form. The slivers are collected into a can through a cooler (not shown).

Incidentally, the broken line in FIG. 1 shows the flow of the staple fibers.

In contrast to the above conventional mechanism, a preferred embodiment of the subject invention will be explained with reference to FIG. 2 as well as Table 2 below.

<table>
<thead>
<tr>
<th>Member</th>
<th>Surface speed (m/min)</th>
<th>Surface speed ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Feed roller</td>
<td>8.2</td>
<td>C/B = 1.2</td>
</tr>
<tr>
<td>B. Take-in</td>
<td>10.7</td>
<td>C/D = 1.2</td>
</tr>
<tr>
<td>C. Carding cylinder</td>
<td>300</td>
<td>C/E = 1.3</td>
</tr>
<tr>
<td>D. Flats</td>
<td>400</td>
<td>C/F = 1.3</td>
</tr>
<tr>
<td>E. Doffer</td>
<td>600</td>
<td>C/G = 1.3</td>
</tr>
<tr>
<td>F. Strip roller</td>
<td>800</td>
<td>C/H = 1.3</td>
</tr>
</tbody>
</table>

In the carding system of the invention, dish plate, feed roller, take-in, carding cylinder and flats can be same to those known and used in conventional carding engines. According to the invention, the surface speed of the feed roller 2 is increased in correspondence to the increased surface speed of the doffer, and the surface speed ratio of the take-in 3 to the feed roller 2 is reduced compared with that in the conventional system. Supplying of the staple fiber lap via the feed roller 2, and carding and paralleling of the staple fibers by the relative motions of carding cylinder 4 and flats 5 are the same to those operations in the conventional carding system as illustrated in FIG. 1. According to the carding system of the invention, the surface speed of the doffer 6 is greater than that of the carding cylinder 4. That is, the surface speed ratio of the doffer to the carding cylinder is greater than 1. Also in order to prevent the surface speed of the doffer from becoming extremely high, the surface speed ratio of take-in/feed roller and that of carding cylinder/take-in are maintained at lower values than those in the conventional system. This should be clear also from comparing the Tables 1 and 2. Thus the staple fibers, which have been carded and paralleled by the relative motions of the teeth of flat 5 and those of the carding cylinder 4, are caught by the teeth on the doffer which is rotating with a surface speed greater than that of the carding cylinder, and are transferred from the surface of carding cylinder to the doffer surface, while receiving the carding action. Whereby the conventionally observed defects, such as formation of end hooks in the staple fibers, or the disturbance of parallel orientation of the fibers, can be effectively avoided.

The web of staple fibers on the doffer 6 is separated from the doffer surface by the action of, for example, rotating roller comb 7 and web roller 8 which are located closely to the circumference of the doffer 6 and at the opposite side from the carding cylinder 4 relative to the center of the doffer 6. Thus separated staple fibers are bundled into sliver and subsequently collected into the cans. The roller comb 7 is preferably mounted with the metallic wire of the structure as described in the pending application filed Aug. 26, 1968. That is, as illustrated also in the attached drawings, FIGS. 3-A, 3-B, and 3-C, the roller comb is preferably mounted with a metallic wire consisting of an upper working section 12 with saw teeth on the top and a base, the height A and pitch of the teeth being, respectively, 1–10 mm. and 2–30 teeth per inch, and each tooth being of the configuration defined by a smoothly projecting curve which tangentially contacts with a line a meeting the horizontal line extending in the longitudinal direction of the metallic wire at an angle α of 90–150° C, and also with another line b which meets with the said horizontal line at an angle β of 30–90° C.

The optimum dimensions of such metallic wire are as follows:

Total height H=2–15 mm.
Base thickness G=0.5–10 mm.
Tip thickness B=0.15–0.5 mm.
Medium thickness C=0.25–0.7 mm.
Radius of curvature R1=0.1–0.170 mm., particularly 0.1–1 mm.
Radius of curvature R2=1–100 mm.
Radius of curvature R3=1–100 mm.
Radius of curvature R4=0.1–20 mm.

Also the web roller 8 preferably is smooth-surfaced. By the combined use of such a roller comb provided with the teeth of specified configuration and smooth-surfaced web roller, it is possible to easily separate the web of staple fibers from the doffer rotating with a high velocity, as well as to separate and collect the staple fibers web without substantially disturbing the parallel orientation of the web on the doffer surface, and substantially without forming the end hooks in the staple fibers.
It is of course permissible to apply such known means for separating and collecting the web from the doffer other than the above combination of a roller comb with a web roller, for example, a pair of press rolls or a conventional roller comb. However in such cases other problems may occur such as the occurrence of separation failure of the fibrous web from the doffer, or operational difficulties in passing the fibers through calender and collector head at the starting of the carding engine.

It is preferred in the process of the subject invention to maintain the surface speed ratio of the doffer to the carding cylinder, within the range of 1.15 - 1.70. In this case, it is also preferred to make the diameter of the doffer 1 - 2 times that of the carding cylinder, so as to prevent the rotation rate of the doffer from becoming excessively high.

The surface speed ratio of take-in to feed roller, that of carding cylinder to take-in, and that of carding cylinder to flats, can be suitably determined, so far as the sufficient carding action can be exerted on the staple fibers and the surface speed of the doffer does not exceed 1,000 m./min.

According to the process of this invention, preferred surface speed ratios between the rollers are as follows:

**TABLE 3.—PREFERRED SURFACE SPEED RATIOS**

<table>
<thead>
<tr>
<th>Taker-in/feed roller</th>
<th>50–300</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carding cylinder/take-in</td>
<td>1.3–1.8</td>
</tr>
<tr>
<td>Carding cylinder/flats</td>
<td>3,000–6,000</td>
</tr>
</tbody>
</table>

The surface speed of the doffer is preferably within the range of 550–800 m./min. If it is less than 500 m./min, sufficient carding of the staple fibers is difficult, and if it exceeds 1,000 m./min., the separation of web of the staple fibers from the doffer becomes difficult. In case the combination of the roller comb and the web roller is used in accordance with the preferred embodiment of the present invention, it is preferred for easy and sure separation of the web from the doffer, to make the surface speed of the roller comb 75–95% of that of the doffer, and to make the surface speed of the web roller 50–200% of that of the roller comb.

The process of this invention is applicable to all the types of staple fibers which have been conventionally subjected to the carding process, such as cotton and synthetic staple fibers including rayon staple, acrylic and polyester fibers.

According to the subject process, due to the above-described characteristic features, occurrence of end hooks in the staple fibers during the conventional carding process is essentially prevented, and furthermore the deficiency inherent in the conventional methods, that the carded and paralleled orientation of the staple fibers is disturbed when the fibers are transferred onto the doffer, is also removed. Thus the fibers spun from the fibrous web or sliver obtained in accordance with the subject method have greater effective length of the staple fibers compared with the fibers obtained through the conventional carding system, and also have the strength improved by 3–5%. The fibers resultant from the subject method also show reduced degree of unevenness.

Again in accordance with the invention, the carded slivers obtained from a pair of take-in end hooks. Therefore the limitation present in the conventional process that the treating steps between the carding and fine spinning procedures must be of an odd number no more holds, but the number of the intervening steps can be freely and optionally selected.

Furthermore, according to the invention the supply of the staple fiber lap can be performed at a speed as high as several times that in the conventional process. Consequently the processable quantity of the staple fibers per one carding machine can also be greatly increased.

The subject method will be hereinafter explained with reference to a working example.

**EXAMPLE**

A lap of cotton produced in U.S.A., mainly in California, was supplied to the carding engine illustrated in FIG. 2. The surface speed ratios of the rollers in the carding engine were as indicated in Table 2. The separation of the web of staple fibers from the doffer was performed by the roller comb mounted with the metallic wire of the structure illustrated in FIG. 3–C. The surface speed of the roller comb was 500 m./min., and the carded slivers were collected into a can at a rate of 120 m./min.

The production rate of the sliver was 440 lbs./hr.

From the slivers, 20- and 40-count single yarns were prepared through the normal first drawing, second drawing, roving and fine spinning.

For comparison, slivers were formed from the same starting material with the known carding engine of the specifications as given in FIG. 1 and Table 1. The production rate of the slivers in that known procedure was 10 lbs./hr.

From the slivers, 20- and 40-count single yarns were prepared by two different procedures, i.e., (A) when the number of treating steps between the carding and fine spinning was even (carding-first drawing-second drawing-subbing frame-inter frame-fine spinning); and (B) when the number of treating steps between the carding and fine spinning was odd (carding-first drawing-second drawing-roving-fine spinning). The results are shown in Table 4 below.

<table>
<thead>
<tr>
<th>TABLE 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Count of Single Yarn]</td>
</tr>
<tr>
<td>29's</td>
</tr>
<tr>
<td>Fiber* strength</td>
</tr>
<tr>
<td>unevenness (lbs.)</td>
</tr>
<tr>
<td>Known method A</td>
</tr>
<tr>
<td>Known method B</td>
</tr>
<tr>
<td>Method of the invention</td>
</tr>
</tbody>
</table>

*The fiber unevenness was graded on the basis of 100 points, by the following method: the sample fibers were wound on a piece of black board of approximately 100 mm. x 200 mm. in size at 1 mm. interval, and the fiber unevenness was examined on the black board in a dark room, under the light of indirect illumination. The basis of judgment was provided by the three-stages standard photographs designated by Nippon Roeki Kensa Kyokai (Japan Spinning Inspection Association), but the intermediate points were given by the visual estimation of the inspectors. In the present example, each five samples of fibers at each treating steps were prepared and five inspections graded them, and the average of the points were calculated, counting as one fractions of more than 6.5 positive and cut away the rest.

Lea strength (lbs.)—The strength was measured by known Lea strength measuring method which is adopted commonly by Nippon Roeki Kensa Kyokai (Japan Spinning Inspection Association) and Nippon Kappa Sen-I Kensa Kyokai (Japan Chemical Analysis Inspection Association). The method is also known internationally.

From the foregoing results, it can be understood that according to the present invention, fibers of less unevenness and higher strength can be prepared, as compared with the products which have been subjected to conventional carding system. The reduction in the fiber unevenness achieved by the subject method is due to the improvement in the parallel orientation of the fibers in the sliver during the carding process, and the improvement in Lea strength of the fibers is caused by the elimination of hooks and improved parallelism of the fibers.

I claim:
1. In the carding process for staple fibers wherein a lap of staple fibers is supplied to the tip of a dish plate by means of a feed roller, brought into contact at the tip with a take-in rotor at a surface speed higher than that of the feed roller, and transferred onto the surface of the take-in; the resultant staple fibers on said take-in are transferred onto a carding cylinder disposed closely adjacent to the periphery of the take-in rotor at a higher surface speed than that of the take-in; the staple fibers thus introduced onto the carding cylinder by the relative fiber lap of the carding cylinder, and the staple fibers located closely adjacent to the periphery of the carding cylinder and above the carding cylinder, are carded; the staple fibers thus produced are transferred from the carding cylinder onto the doffer rotating closely adjacent to
the periphery of the carding cylinder; and the web of fibers is detached from the surface of the doffer and collected into a sliver form; improvements in the carding process comprising maintaining the surface speed of said doffer at 1.15 to 1.70 times that of said carding cylinder and at 550 to 800 m./min.; driving the taker-in at a surface speed 50-300 times that of the feed roller; driving the cylinder at a surface speed of 1.3-1.8 that of the taker-in; driving the cylinder at a surface speed 3,000 to 6,000 times that of the flats; and detaching a card web from the surface of said doffer with a roller comb located closely adjacent to the periphery of said doffer rotating in the direction the same as that of said doffer on the opposite side to said carding cylinder with respect to the center of said doffer, said roller comb being covered with metallic wire having saw teeth defined by a smoothly outwardly projecting curve.

2. Improvements in the carding process according to claim 1 wherein the surface speed of said roller comb is 75 to 95% of that of said doffer.

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