May 29, 1962 P. M. STRANG 3,036,343

METHOD OF AND APPARATUS FOR USE IN CARDING STAPLE-LENGTH TEXTILE FIBER

Filed April 2, 1959 2 Sheets-Sheet 1

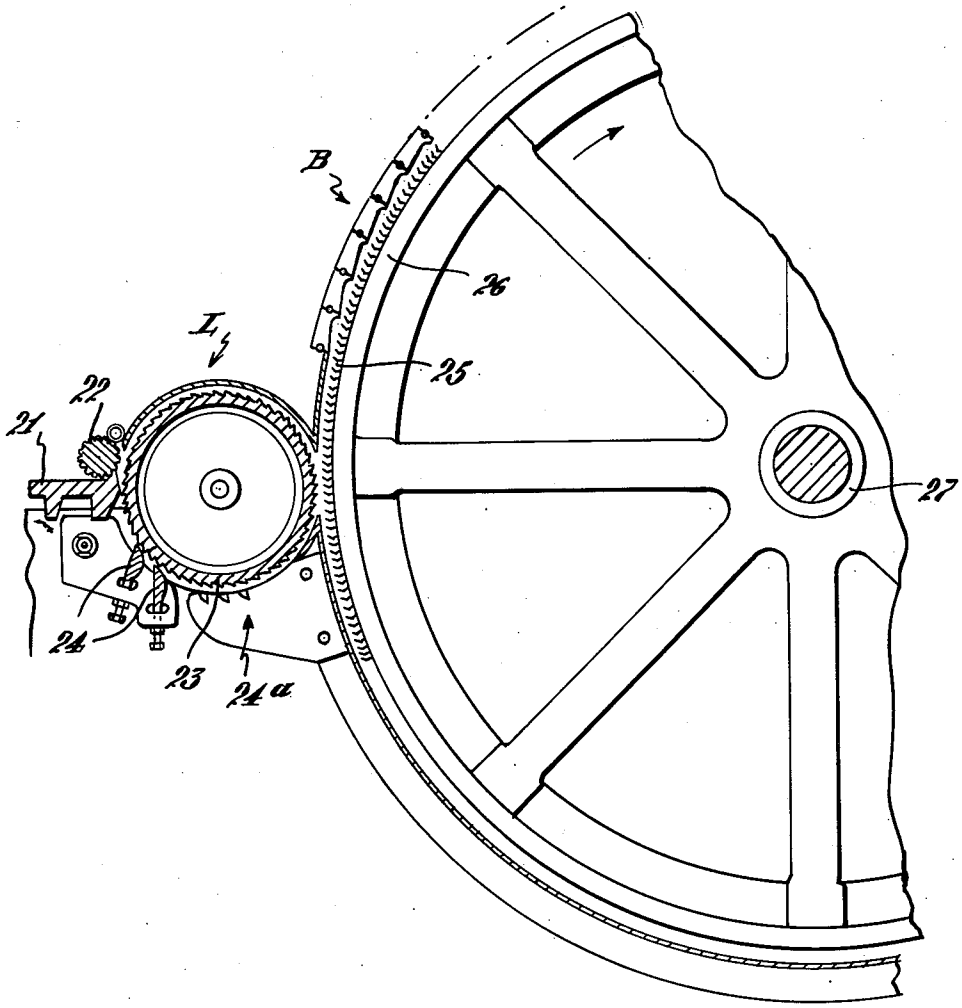


Fig. 1

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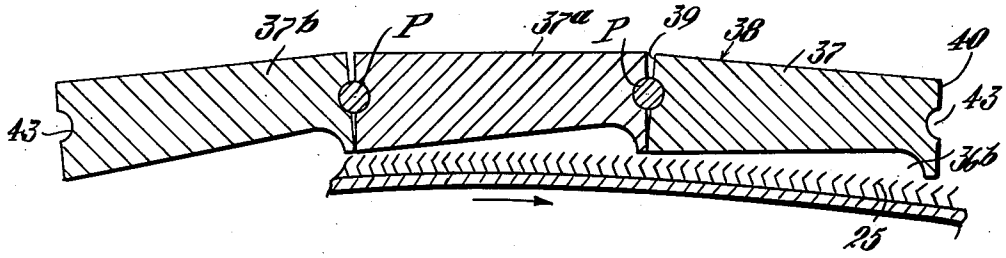


Fig. 3

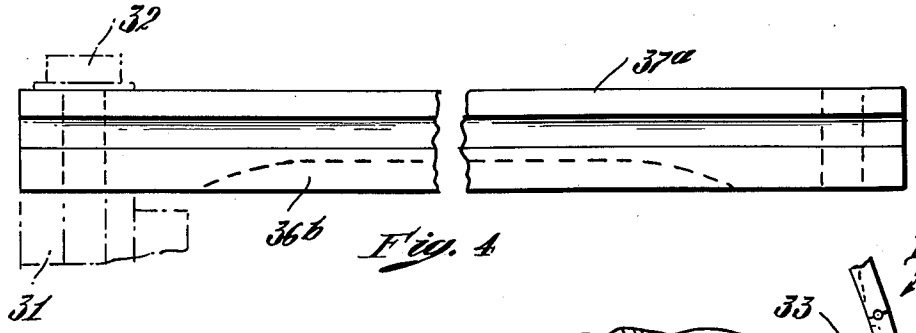


Fig. 4

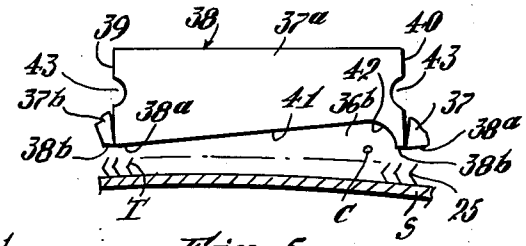


Fig. 5

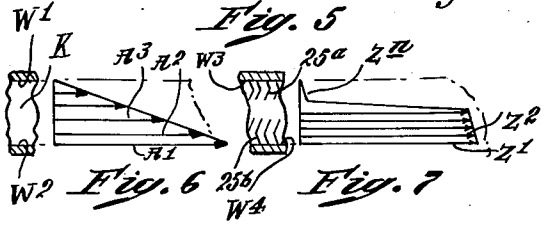


Fig. 6

Fig. 7

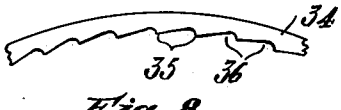


Fig. 8

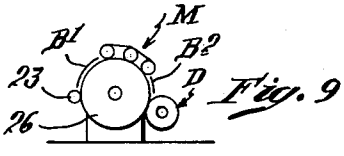


Fig. 9

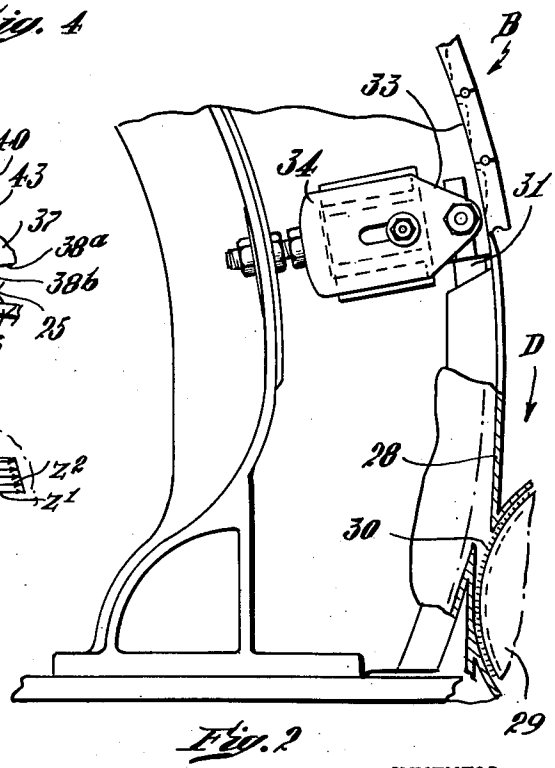


Fig. 2

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United States Patent Office 3,036,343 Patented May 29, 1962

3,036,343

METHOD OF AND APPARATUS FOR USE IN CARDING STAPLE-LENGTH TEXTILE FIBER

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Filed Apr. 2, 1959, Ser. No. 803,737
14 Claims. (Cl. 19—104)

This invention pertains to textile fiber preparation and more especially to a novel method of and apparatus for use in carding staple-length textile fiber, of which cotton is hereinafter referred to, but without limitation, as an example.

Preparatory to spinning fiber into yarn, and especially if the fiber be of natural origin, for instance cotton or wool, many preliminary operations are required in order to insure the production of yarn of uniform character, in particular such operations as blending or mixing to insure uniformity of length, grade, color, etc.; opening and cleaning to loosen dense lumps of adherent fibers and to facilitate the removal of impurities such, for instance, as parts of the cotton plant, burrs, sand, etc.; and the reduction of the cleaned fiber to the form of a coherent sliver which may be subjected to such operations as drawing, doubling, etc., immediately preceding actual spinning. Among the last of these preparatory operations is that of carding whereby the fiber, which has already been opened and cleaned to a substantial extent (although individual fibers are still clinging together in the form of tufts and without any regular order) is further loosened so as to isolate individual fibers, so far as may be practical; foreign substances not previously eliminated are removed; exceptionally short fibers are separated as waste; the useful fibers are brought into some degree of parallelism and are uniformly distributed to form a fleece of even thickness from edge to edge; and the conversion of this fleece into a sliver of uniform weight per yard. Since the early days of machine carding, the distribution of the fibers to form a substantially uniform fleece of even thickness has been practiced by distributing the fibrous material (as received in bat form from one of the preliminary machines) over the face of a rotating drum covered with projecting teeth usually of the form known as "card clothing" and, while rotating this drum slowly in one direction, engaging the exposed surface of the fibrous fleece, adherent to the teeth on the drum, with a similar toothed surface, either stationary or moving slowly relatively to the drum, the general theory of operation apparently having been that the two sets of opposed teeth or pins, one set moving relative to the other exert a combing action whereby the fibers are loosened so that foreign matter and short fibers are separated and the staple-length fibers uniformly distributed and, in theory at least, arranged more or less parallel. This commonly accepted idea as to the mode of operation of the conventional card was based upon results rather than upon careful analysis of the actual operation and fails to explain such questions as:

(1) Why does the cylinder of a card load during operation?

(2) Why does the doffer load during operation?

(3) Why are accurate settings necessary between cylinder and licker-in, cylinder and flats, cylinder and percentage plate, cylinder and doffer and cylinder and under screens?

(4) Why does a cylinder speed of 165 r.p.m. necessarily give the best results?

(5) Why does the centrifugal force of the cylinder not throw the fibers back on the licker-in or on the flats?

(6) Why are present types of card clothing satisfactory?

(7) Why does a card operate when its cylinder is covered with non-flexible clothing which is similar to the covering of a licker-in?

(8) Why does a continuous stripper on a cylinder cause a card to operate satisfactorily, in some instances, even though it tends to dull the wire on the cylinder?

It may be noted that as the result of practical experience in the mill, and as respects the operation, for example, of the conventional revolving-flat card, the setting of the flats relatively to the rotating cylindrical drum, as well as the angular velocity of the drum for optimum results, have become substantially standard in the industry.

A recent effort to explain the operation of the conventional card has approached the problem from the standpoint of fluid dynamics. The theory of fluid dynamics establishes that in the flow of fluids about a rotating cylinder the velocity of the fluid at the surface of the cylinder equals the velocity of the cylindrical surface itself, and that when fluid flows in a channel the velocity of the fluid at the channel wall is zero, but increases very rapidly from zero to a finite value in a very narrow boundary layer along the channel wall. In considering how this principle may be involved in the action which takes place in a revolving-flat card, it may first be noted that the cylinder is covered with card clothing, the flat or flats being likewise covered with card clothing, and in common practice so arranged that the ends of the teeth of the card clothing on the cylinder are spaced approximately 0.009 inch from the tips of the teeth on the flat and, that the flats may be considered as stationary as compared with the very high surface velocity of the cylinder, the flats collectively defining the perimeter of a space or channel bounding a layer of air which is dragged along by the cylinder as the latter rotates. Because the several filaments of air forming this boundary layer having very different velocities, the outermost filament, as above noted, having substantially zero velocity, any fibers which are introduced into this boundary layer are subjected to powerful shearing forces between the adjacent air filament, such forces acting in general circumferentially of the cylinder. On the other hand, because of the high rotational velocity of the cylinder, the fibers are likewise subjected to centrifugal force of substantial magnitude. Mathematical calculations based upon the employment of a cylinder covered with card clothing having 72,000 points or teeth of 33 American gauge wire per square foot, and assuming the customary cylinder speed of 165 r.p.m. and assuming that the card is designed to produce ten pounds of carded cotton per hour, appear to show that there are more than 86,800 cubic inches of air available to act upon each cubic inch of fiber to be carded, so that the volume of cotton being carded is extremely small as compared with the volume of air in which powerful shearing forces are taking place as the cylinder revolves. Thus the card may be thought of as a machine for generating a high velocity confined air stream in which a relatively minute quantity of fibrous material is suspended.

The present invention is designed to take advantage of these fluid dynamic principles and in particular the shearing forces within the boundary layer of air surrounding the cylinder and so as to control the flowing boundary layer of air surrounding the cylinder as to accentuate such shearing forces while guiding the air to follow a course such as to improve the carding operation with respect to the straightening of the fibers and a decrease in the formation of neps such as usually result from the formation of eddies in a body of air in which fiber is floating.

In accordance with the novel method of carding, according to the present invention, the fiber to be carded is distributed over the teeth of a layer of card clothing and a current of air is caused to flow along said layer of card clothing and in contact with the fiber carried by the latter, and at regularly recurring intervals, the velocity and pressure of the air forming said current is first increased and then its pressure and velocity are decreased.

One desirable apparatus for use in the practice of this novel method comprises a rotatable cylinder whose periphery is covered with outwardly directed teeth, a device for distributing the fiber to be carded over said teeth, mechanism for rotating the cylinder whereby the air surrounding the cylinder is entrained by the teeth and constrained to flow as a current about the circumference of the cylinder, and an air-confining barrier, extending about a predetermined arc, at least, of the cylinder, the inner surface of said barrier being of a shape such as, at recurrent intervals, first to increase the pressure and velocity of the air forming said current and then to decrease the pressure and velocity of said air.

In the practice of the invention, the outer filaments of the air current, which are generated by the rotation of the cylinder, are caused, at regularly recurring intervals, throughout a predetermined arc of the circumference of the cylinder, first to move outwardly away from the tips of the teeth of the card clothing and then to move inwardly toward the tips of said teeth, with a gradual decrease in velocity and pressure of the air as it so moves outwardly and a more abrupt increase in velocity and pressure as the air moves inwardly toward the cylinder, and so confining the air current that at the points of high velocity it forms jets substantially tangent to the surface of the cylinder. More specifically, the present invention provides a method and apparatus for use in carding fibrous material which comprises, first distributing the material over a surface to which the fibrous material tends to cling, for example, a surface consisting of card clothing, then causing a current of air to flow over said surface always in the same direction, and so confining said air current that, as it flows, it forms recurrent high velocity, high pressure jets substantially parallel to said surface, while in the intervals between successive jets it moves more slowly with gradually decreasing pressure. For the practice of this method it is preferred to employ a carding machine comprising a rotatable cylinder covered with card clothing, but relatively stationary means having cooperation with the cylinder, which so constrains the air current generated by the rapidly moving card clothing that the velocity of the air current is alternatively increased and decreased and forms recurrent high velocity jets directed tangentially of the cylinder wherein the velocity of the air current is at a maximum.

In the attainment of this desirable object, the present invention contemplates substituting for some or all of the customary flats of the revolving-flat card, a stationary barrier, preferably comprising a series of rigid bars or the equivalent, thereof embracing a portion of the carding cylinder or drum and extending from end to end of the latter so as to define the outer boundary of the layer of air which is entrained by the moving drum. Said barrier (in substitution for the customary flats) being designed to provide a series of elongate chambers or channels, each extending longitudinally of the drum and each gradually increasing in radial depth, beginning at one edge of the channel to a point of maximum depth and then suddenly decreasing in depth in a smooth arc to the opposite edge of the channel, the channels being separated by portions of the barrier which are spaced a very short distance, for instance a distance of 0.009 inch, from the tips of the teeth of the card clothing on the drum.

In the accompanying drawings, wherein certain desirable embodiments of the invention are illustrated by way of example,

FIG. 1 is a fragmentary radial section showing a portion of the drum of a carding machine, according to the present invention, illustrating the licker-in side of the apparatus;

FIG. 2 is a fragmentary end elevation, partly in radial section, of the apparatus of FIG. 1, but showing the doffer side of the apparatus;

FIG. 3 is a fragmentary radial section, to much larger scale than FIG. 1, showing a portion of the air confining barrier, which cooperates with the drum, in accordance with a preferred embodiment of the invention;

FIG. 4 is an edge elevation of one of the constituent bars of the barrier shown in FIG. 3;

FIG. 5 is an end view of a single barrier bar in detail, with small portions of the adjacent bars, and indicating the path of the tips of the teeth of the rotating cylinder with relation to the inner surface of the barrier bars;

FIG. 6 is a diagram suggestive of the variation in air velocity between a fixed smooth surface and a smooth rotating surface;

FIG. 7 is a view similar to FIG. 6, but showing what is believed to represent the actual variation in velocity in the current of air which is created between a rotating cylinder covered with card clothing and a stationary surface covered with card clothing;

FIG. 8 is a fragmentary radial section illustrating a barrier of another form such as might be employed in the practice of the invention; and

FIG. 9 is a small scale diagrammatic end elevation of so much of a carding machine as is necessary to illustrate one arrangement in which barrier means, in accordance with the present invention, is employed in association with revolving flats.

The theory of carding, believed to be involved in the present invention, may be understood by reference to FIGS. 6 and 7. Thus, in FIG. 6, the character W^1 designates the fixed wall of a smooth surfaced channel K whose opposite wall W^2 is moving relatively to the wall W^1 and parallel to the latter and toward the right, as viewed in FIG. 6. In such an arrangement, according to the theory of flow of elastic fluids, the filament of air which contacts the wall W^2 will move at the same velocity as the latter, this velocity being indicated by the arrow A^1; while filaments of air between the walls W^2 and W^1 will have progressively decreasing velocities as indicated by the arrows A^2, A^3, etc., until, at the wall W^1, the air will be of zero velocity, assuming that wall W^1 is stationary. However, in apparatus such as a textile card (FIG. 7), wherein the opposed walls of the channel are formed by card clothing, the relative velocities of the filaments of air contacting the wall W^3 (which, for example, may represent a stationary card flat having the card clothing **25***a*) and the wall W^4 (which may be a rotating card cylinder having the card clothing **25***b*), the relative velocities of the filaments of air in contact with the walls W^4 and W^3, respectively, may probably be represented by the lengths of the parallel lines Z^1, Z^2, etc., it being noted that in this case the velocity is probably nearly constant for a substantial distance outwardly from the periphery of the rotating cylinder and increases (as indicated at Z^n) from zero at the base of the stationary card clothing **25***a*, with an abrupt velocity gradient between the tips of the teeth of the card clothing on the flat and the tips of the teeth of the card clothing on the cylinder. The present invention takes advantage of this fact by so controlling the air current, outwardly beyond the ends of the teeth of the card clothing on the cylinder, as to utilize the maximum air sheer at this point to the best advantage in loosening and straightening the fibers and in bringing them into generally parallel relation.

Referring to FIGS. 1–5 of the drawings, the character L (FIG. 1) indicates generally the conventional licker-in mechanism of a carding machine. The lap of fiber to be carded is advanced along the feed apron **21**, in usual manner, to the feed roll **22** which delivers it to the toothed licker-in roll **23** which, in turn, carries it across the grid bars **24** and screen **24***a* and distributes it over the surface

defined by the tips of the teeth or pins of the card clothing **25**, which covers the peripheral surface of the carding cylinder **26** mounted on the shaft **27**, which is driven by the usual mechanism (not shown). A customary cylinder speed of 165 r.p.m. and a cylinder surface speed of the order of 36 feet per second may be cited merely as illustrative of good practice. The card clothing may be of any conventional type, for example, that which has 72,000 teeth or pins per square foot, the teeth or pins being of No. 33 American gauge wire. However, for the practice of the present invention, other types of teeth may be employed on the peripheral surface of the cylinder.

The character D (FIG. 2) indicates, in general, the location of a conventional doffer mechanism which is approximately diametrically opposite to the licker-in mechanism and which includes, among other things, the doffer knife-plate **28**; the doffer cylinder **29**; and the card clothing **30** carried by the latter.

In accordance with the present invention, there is provided, in substitution for the customary revolving-flats, or in substitution for a portion of the revolving-flats, a device herein for convenience referred to as a "barrier" and which is indicated generally by the character B in FIGS. 1 and 2. If desired, this barrier may extend (FIG. 1) from a point just above the licker-in mechanism (in the direction of motion of the carding cylinder), upwardly and around the carding cylinder and down to a point just above the doffing mechanism, as indicated in FIG. 2. On the other hand, this barrier may, if preferred, extend only part of the way about the working arc of the carding cylinder, the balance of that arc of the carding cylinder (which is located between the licker-in and the doffer) being occupied by conventional revolving-card mechanism. In that event the carrier may extend, as a unit, continuously through a predetermined arc of the cylinder, the remainder of the working arc of the cylinder having associated therewith licker-in mechanism, as indicated in FIG. 9, or the barrier may be divided into two segments, B^1 and B^2, one adjacent to the licker-in and the other adjacent to the doffer, and the intervening arc occupied by the conventional revolving-card mechanism M. Preferably, in accordance with the present invention, this barrier extends, as first suggested, from a point adjacent to the licker-in to a point adjacent to the doffer.

This barrier extends circumferentially of the carding cylinder with its inner face generally concentric with the carding cylinder and spaced, at all points, from the surface defined by the tips of the teeth of the card clothing and is carried by rings **31** (FIGS. 2 and 4), located at opposite ends respectively of the cylinder **26**, to which the barrier is connected by bolts **32** (FIG. 4), the rings being adjustably attached to the frame of the carding machine by brackets (FIG. 2), comprising parts **33** and **34** which are relatively adjustable radially of the cylinder. However, other means for supporting the barrier may be employed within the scope of the invention.

The barrier may, if desired, be a continuous structure, for example as suggested in FIG. 8, consisting of a unitary arcuate mass of material (indicated at **34**, FIG. 8), for instance of molded metal or possibly other material, for example, one of the synthetic plastics or such a plastic reinforced with appropriate material to form a rigid structure, the inner surface of this elongate arcuate member **34** being shaped to provide a series of ribs **35** with intervening channels **36**, these ribs and channels extending longitudinally of the carding cylinder and substantially from end to end of the latter, although the channels should terminate a short distance inwardly from the ends of the cylinder.

While such a unitary barrier may be employed (it being understood that this barrier will extend throughout that arc of the cylinder at which the barrier is to function), it is preferred, for ease in manufacture, as well as for accuracy in adjustment, to make this barrier as disclosed in detail in FIGS. 3, 4 and 5. In accordance with this preferred procedure, the barrier consists of a series of individual bars **37**, **37*a***, **37*b***, etc., the several bars being identical in construction and being made of any suitable rigid material, for example metal or such other substance as may prove to be useful for the purpose. These bars, may be molded to final shape, if of a material which can be molded, or each bar may initially be substantially rectangular in transverse section and of a length to extend substantially from one end of the cylinder to the other. Thus each bar may, for example, have the outer flat face **38** (FIGS. 3 and 5), the parallel edge faces **39** and **40**, and an initially flat face, parallel to the face **38**, which, during the process of making the bar, is cut away until only marginal portions **38*a*** and **38*b*** (FIG. 5) remain, these marginal portions being substantially flat and in the same plane. However, it is contemplated that, for extreme accuracy, these marginal faces **38*a*** and **38*b*** may be curved to be concentric with the peripheral surface of the carding cylinder. Ordinarily, because of the diameter of the barrier, flat surfaces at **38*a*** and **38*b*** sufficiently approximate concentricity with the carding cylinder to provide all necessary accuracy.

The inner face of each bar, between the proximate edges of the faces **38*a*** and **38*b***, is cut away to provide the longitudinally extending channel **36*b***. Experiment appears to indicate that for optimum results the major portion of the wall of this channel should be a rectilinear surface **41** (FIG. 5), inclining outwardly from the plane of the faces **38*a*** and **38*b*** at an angle of the order of 7°, although it is contemplated that this angle may vary slightly in accordance with the type of material with which the machine is intended to operate.

The wall of the channel also comprises the arcuate portion **42**, which is concave rearwardly, as referred to the direction of rotation of the cylinder and whose center of curvature (indicated at C, FIG. 5) is in the plane of the marginal faces **38*a*** and **38*b*** and whose radius may, for example, be of the order of $\frac{7}{32}$ of an inch. As illustrated in FIG. 5, the rectilinear surface **41** is tangent to this arcuate surface **42** at the point at which the depth of the channel **36*b***, measured from the plane of the surfaces **38*a*** and **38*b***, it is at a maximum. In FIG. 5, the position of one of these bars, in particular the bar **37*a***, is shown in its relation to the card clothing **25**, the latter, for convenience in this view, being shown as resting upon a support S, the geometrical surface defined collectively by the tips T of the teeth of the card clothing being indicated by a broken line and as spaced from the plane of the surfaces **38*a*** and **38*b***. In actual practice, this space may, for example, be of the order of 0.009 inch. As shown in FIG. 5, where portions of three of the bars are indicated, it will be seen that the proximate edges of the surface **38*b*** and **38*a*** of the bars **37*b*** and **37*a***, are substantially in contact and likewise that the edges of the marginal surfaces **38*b*** and **38*a*** of the bars **37*a*** and **37*b*** are substantially in contact, the two abutting marginal surfaces at each of these points collectively defining the effective width (circumferentially of the cylinder) of one of the ribs **35** of the barrier device. As illustrated, FIGS. 3, 5 and 8, the width of the rib is but a small fraction of the width of the groove or channel, for example, if the width of the channel be two inches, the width of the rib may be of the order of seven-thirty-seconds of an inch.

Referring to FIG. 4, it may be noted that the groove or channel **36*b*** in the bar **37*a***, for example, terminates at a substantial distance from the opposite ends of the bar, a distance of the order of $1\frac{3}{8}$ being suggested by way of example, since this provides ample space between the end of the bar and the end of the channel for the reception of the attaching bolt **32**, by means of which the bar is secured to the supporting ring **31**, while at the same time closing the channel at its ends.

Each of the lateral edges **39** and **40** of the bar is provided with a longitudinally extending groove **43**, preferably substantially midway between the surface **38** and

the inner surface of the bar, these grooves being desirably substantially semi-circular in transverse section and being designed to receive packing P (FIG. 3) which provides a substantially air-tight joint between adjacent bars, thus preventing leakage of air outwardly through the barrier so that the current of air, which is generated by the entraining action of the teeth of the card clothing as the cylinder revolves, is confined to the space between the inner surface of the barrier and the outer surface of the base fabric of the card clothing.

It will be observed that the inner face of the barrier, to wit, that face which is opposed to the tips of the teeth of the card clothing, is smooth, that is to say, it is devoid of anything corresponding to points or pins like those of card clothing, so that the flow of the air current created by the revolving cylinder is not affected other than by the specific shape or contour of the inner surface of the barrier and the card clothing on the cylinder. This barrier is normally stationary (although it is contemplated that under some circumstances bars such as those herein shown as constituting the barrier may be substituted with appropriate housing or encasing means) for the usual flats of the revolving-flat card.

With this arrangement it will be observed that the inner surfaces of the ribs 35 of the barrier are very close to the surface defined by the tips T of the card clothing; and since these ribs are regularly spaced apart, circumferentially of the cylinder, they produce regularly recurrent restrictions or orifices such that, in passing these ribs, the air current is increased in velocity so that it passes each rib as a high velocity, high pressure jet, very thin in a radial direction but extending longitudinally of the cylinder, and which is directed substantially tangentially to the surface defined by the tips T of the teeth of the card clothing. Experiment shows that in an arrangement such as herein disclosed, wherein the barrier is substantially air-tight, pressure builds up between the bars and cylinder such that the air forming the jets has a velocity exceeding that of the surfaces of the cylinder. On the other hand, intervening between each adjacent pair of ribs there is one of the channels 36*b*, forming a chamber of forwardly increasing capacity, radially, in which the jet may expand and gradually lose velocity until, at the portion of the chamber 36*b* which is of maximum radial width, there is a zone of relative quiet and low pressure. However, it will be noted that beyond this point of maximum width, the chamber decreases very rapidly in radial width by reason of the short radius arcuate surface 42, so that the outer filaments of air, following the surface 41 are suddenly bent inwardly and ultimately turned into a direction substantially perpendicular to the geometrical surface defined by the tips of the card clothing teeth, these filaments moving initially radially of the card clothing and then suddenly being entrained with those filaments of the air stream which have been following the tips of the teeth and carried into the jet stream in the narrow orifice beneath the rib. Thus there is a terrific sheering action between constituent filaments of the air stream which is imposed upon the fiber suspended in the air stream, thereby tending to drag the fiber out longitudinally and to separate each fiber from other adjacent fibers. Desirably the ribs of the barrier are spaced apart a distance substantially exceeding the average staple length of the fibers which are to be carded, for example, for commercial cotton of a rated one inch staple and which contains a substantial number of fibers of 1½ inch length, a distance of two inches between adjacent ribs has been found satisfactory for the purpose.

Because of the small angle between the surface 41 of the wall of the channel in the bar and the plane defined by the marginal faces 38*a* and 38*b*, the formation of eddies along the surface of the cylinder is reduced to a minimum and, as above noted, as the width of the channel increases the velocity of the air current moving along with the cylinder and through this chamber decreases and its pressure likewise decreases. The alternating increase and decrease in velocity and pressure has been found highly effective in loosening and straightening the fibers, and carding by the employment of this relatively simple arrangement increases production and produces a sliver which is more than usually uniform and having its constituent fibers more nearly parallel than is customarily the result of the employment of conventional carding machines.

While certain desirable embodiments of the invention have herein been disclosed by way of example, it is to be understood that the invention is broadly inclusive of any and all modifications falling within the scope of the appended claims.

I claim:

1. That method of carding textile fiber by the use of a rotating cylinder whose peripheral surface is covered with card clothing having outwardly directed teeth, which comprises as steps: distributing the fiber to be carded over the teeth of the card clothing, and rotating the cylinder thereby generating a current of air which follows the periphery of the cylinder, causing the outer filaments at least of said air current, at regularly recurring intervals throughout a predetermined arc of the circumference of the cylinder, first to move smoothly outwardly and without the formation of eddies away from the tips of the teeth of the card clothing while continuing, without interruption, in the same general direction and then to move abruptly inwardly toward the tips of said teeth.

2. The method according to claim 1, wherein the filament of air which move outwardly away from the cylinder make an angle of approximately 7° with a tangent to the surface defined by the tips of the teeth and then move inwardly toward said surface in an arcuate path whose center of curvature is at said surface.

3. That method of carding fibrous material which comprises as steps: distributing the fibrous material over a surface to which the fibrous material tends to cling, causing a current of air to flow over said surface always in the same direction, and so confining and guiding said air current that it moves in the form of regularly recurrent high velocity, high pressure jets substantially parallel to said surface and, intermediate successive jets, the outer filaments, at least, of said air current move more slowly, outwardly away from said surface, without the formation of eddies and with gradually decreasing pressure.

4. That method of carding fiber of textile length by the use of a rotating cylinder having a peripheral layer of card clothing which comprises as steps: distributing fiber to be carded, in accordance with conventional methods, over the surface defined by the tooth tips of the card clothing, confining the fiber so distributed between the tips of the card clothing and a stationary substantially air-tight wall extending about a predetermined portion, at least, of the periphery of the cylinder, rotating the cylinder thereby to create a current of air flowing in the space between said card clothing and wall and in the direction of rotation of the cylinder, and at regularly recurring intervals circumferentially of the cylinder, first so gradually increasing the radial thickness of said current as to avoid the formation of eddies and then relatively abruptly decreasing the radial thickness of the air current so that its velocity exceeds that of the surface of the cylinder.

5. That method of carding fiber of textile length by the use of a rotating cylinder having a peripheral layer of card clothing which comprises as steps: distributing the fiber to be carded over the surface defined by the tooth tips of the card clothing, confining the fibers so distributed between the tips of the teeth of the card clothing and a stationary substantially air-tight wall extending about a portion, at least, of the periphery of the cylinder, rotating the cylinder and thereby causing a current of air to flow in the space between said card clothing and wall and in the direction of rotation of the cylinder, and at regularly recurrent intervals widening the air current radially at a rate

corresponding to an angle of the order of 7° to a tangent to the periphery of the cylinder thereby decreasing the pressure but without forming eddies and then relatively suddenly reducing the radial width of the air current and increasing the pressure by constraining its outer filaments to move toward the periphery of the cylinder along an arc of a radius of the order of 7/32 of an inch.

6. In a carding machine of the kind which includes a rotatable cylinder whose periphery is covered with outwardly directed teeth and including a device operative to distribute fiber to be carded over said teeth, mechanism for rotating the cylinder whereby the air surrounding the cylinder is entrained by the teeth and constrained to flow as a current about the circumference of the cylinder, and an air-confining barrier extending about a predetermined arc at least of the cylinder, the inner surface of the barrier comprising a plurality of longitudinally extending radial, shallow channels spaced apart circumferentially of the cylinder by intervening, relatively narrow ribs, the inner faces of all of said ribs being spaced the same distance from the geometrical surface defined by the tips of the teeth whereby at recurrent intervals, first to increase the pressure and velocity of the air which forms said current and then to decrease the pressure and velocity of said air current.

7. The combination according to claim 6, wherein the shapes of the channels and ribs are such that at regularly recurrent intervals the current forms high velocity jets directed tangentially of the surface defined by the tips of the teeth, and in the intervals between said jets flows smoothly and at a relatively low velocity.

8. In a carding machine of the kind which includes a rotatable cylinder whose periphery is covered with card clothing having outwardly directed teeth and including means operative to distribute fiber to be carded over the surface of the card clothing, means for rotating the cylinder whereby the air surrounding the cylinder is entrained by the teeth of the card clothing and constrained to flow as a current about the circumference of the cylinder, a substantially air-tight barrier which extends circumferentially of the cylinder throughout a predetermined part of the circumference of the latter, said barrier being spaced at all points from the surface defined by the tips of the teeth of the card clothing, said barrier comprising a plurality of circumferentially narrow, peripherally spaced ribs, each rib extending longitudinally of the barrier, the inner faces of the ribs being so spaced from the geometrical cylindrical surface defined by the tips of the teeth of the card clothing that the air current in passing said ribs in constrained to form high velocity jets substantially tangent to said geometrical surface, the inner surface of the barrier, which intervenes between each pair of adjacent ribs, being smooth and of a shape to form a channel relatively wide as compared with the ribs, extending longitudinally of the cylinder, and wherein the velocity of the air current, circumferentially of the cylinder, is relatively low as compared with that at the jets, and wherein the inner surfaces of the ribs are smooth and substantially parallel to the geometrical surface defined by the tips of the teeth of the card clothing and are spaced from said surface a distance of the order of 0.009 inch.

9. In a carding machine of the kind which includes a rotatable cylinder whose periphery is covered with card clothing having outwardly directed teeth and including means operative to distribute fiber to be carded over the surface of the card clothing, means for rotating the cylinder whereby the air surrounding the cylinder is entrained by the teeth of the card clothing and constrained to flow as a current about the circumference of the cylinder, a substantially air-tight barrier which extends circumferentially of the cylinder throughout a predetermined part of the circumference of the latter, said barrier being spaced at all points from the surface defined by the tips of the teeth of the card clothing, said barrier comprising a plurality of circumferentially narrow, peripherally spaced ribs, each rib extending longitudinally of the barrier, the inner faces of the ribs being so spaced from the geometrical cylindrical surface defined by the tips of the teeth of the card clothing that the air current in passing said ribs in constrained to form high velocity jets substantially tangent to said geometrical surface, the inner surface of the barrier, which intervenes between each pair of adjacent ribs, being smooth and of a shape to form a channel relatively wide as compared with the ribs, extending longitudinally of the cylinder, and wherein the velocity of the air current, circumferentially of the cylinder, is relatively low as compared with that at the jets, and wherein the distance between successive ribs of the barrier substantially exceeds the staple-length of the fibers to be carded.

10. In a carding machine of the kind which includes a rotatable cylinder whose periphery is covered with card clothing having outwardly directed teeth and including means operative to distribute fiber to be carded over the surface of the card clothing, means for rotating the cylinder whereby the air surrounding the cylinder is entrained by the teeth of the card clothing and constrained to flow as a current about the circumference of the cylinder, a substantially air-tight barrier which extends circumferentially of the cylinder throughout a predetermined part of the circumference of the latter, said barrier being spaced at all points from the surface defined by the tips of the teeth of the card clothing, said barrier comprising a plurality of circumferentially narrow, peripherally spaced ribs, each rib extending longitudinally of the barrier, the inner faces of the ribs being so spaced from the geometrical cylindrical surface defined by the tips of the teeth of the card clothing that the air current in passing said ribs is constrained to form high velocity jets substantially tangent to said geometrical surface, the inner surface of the barrier, which intervenes between each pair of adjacent ribs, being smooth and of a shape to form a channel relatively wide as compared with the ribs, extending longitudinally of the cylinder, and wherein the velocity of the air current, circumferentially of the cylinder, is relatively low as compared with that at the jets, and wherein the inner surface of the barrier, between successive ribs, is smooth and slopes outwardly from one edge of each channel at an angle of the order of 7° to a tangent to the geometrical surface defined by the tips of the teeth of the card clothing and then extends inwardly to the opposite edge of the channel in an arc of the order of 7/32 of an inch, whose center of curvature is in the plane defined by the inner surfaces of successive ribs, whereby the channel intervening between successive ribs is of a maximum depth of the order of 7/32 of an inch.

11. A carding machine of the kind which includes a rotatable cylinder whose periphery is covered with card clothing having outwardly directed teeth and including means operative to distribute fiber to be carded over the surface of the card clothing, means for rotating the cylinder whereby the air surrounding the cylinder is entrained by the teeth of the card clothing and constrained to flow as a current about the circumference of the cylinder, a substantially air-tight barrier which extends circumferentially of the cylinder throughout a predetermined part of the circumference of the latter, said barrier being spaced at all points from the surface defined by the tips of the teeth of the card clothing, and wherein the barrier comprises a plurality of elongate unitary, imperforate rigid bars, each of said bars being substantially rectangular in transverse section, each bar having an outer face, parallel edge faces and an inner face, the latter including marginal portions which lie in a plane parallel to a tangent to the geometrical cylinder formed by the tips of the teeth and which intersect the respective edge faces at right angles, the inner surface of the bar, intermediate said marginal portions, comprising a substantially rectilinear smooth face, which inclines outwardly and forwardly from its intersection with the rear one of said

marginal faces and merges, forwardly, with a concave arcuate face which intersects the other marginal face at a right angle.

12. A carding machine of the kind which includes a rotatable cylinder whose periphery is covered with card clothing having outwardly directed teeth and including means operative to distribute fiber to be carded over the surface of the card clothing, means for rotating the cylinder whereby the air surrounding the cylinder is entrained by the teeth of the card clothing and constrained to flow as a current about the circumference of the cylinder, a substantially air-tight barrier which extends circumferentially of the cylinder throughout a predetermined part of the circumference of the latter, said barrier being spaced at all points from the surface defined by the tips of the teeth of the card clothing, and wherein the barrier comprises a plurality of elongate rigid bars, each extending substantially from end to end of the cylinder, means for uniting said bars leak-tight with their longitudinal edges in contact, each bar having a surface which is opposed to the geometrical surface defined by the tips of the teeth, said surface of the bar comprising marginal faces lying in the same plane and a single imperforate intervening portion of a width substantially exceeding the combined width of said marginal faces and which defines a channel extending longitudinally of the bar, the wall of the channel being smooth and imperforate and comprising a substantially rectilinear portion and an arcuate portion, the rectilinear portion inclining at an angle of the order of 7° to the plane defined by said marginal faces, and the arcuate portion being of a radius of curvature of the order of 7/32 of an inch with its center of curvature in the aforesaid plane, the rectilinear surface being tangent to the arcuate surface at the point of maximum radial depth of the channel.

13. The combination according to claim 12, wherein the channel in each bar extends throughout the major portion of the length of the bar but terminates at a distance of the order of 1⅜ of an inch from the extreme end of the bar at opposite ends respectively.

14. In combination with a rotatable cylindrical drum whose surface is of a character such that fibrous material distributed over said surface is carried along an arcuate path as the drum revolves, means for delivering fibrous material to the peripheral surface of the rotating drum, and air-tight barrier means cooperable with the drum to define a plurality of radially, narrow orifices spaced uniformly about a predetermined arc of the circumference of the drum, each orifice extending parallel to the axis of the drum and throughout the major portion of the width of the drum, said barrier means also defining chambers, each of a maximum radial depth greater than the radial depth of an orifice, each chamber intervening between two successive orifices and being of a length, circumferentially of the drum, substantially exceeding the length, circumferentially of the drum, of one of said orifices, whereby the barrier means, in cooperation with the rotating drum, confines the air which moves in an arcuate path following the circumference of the drum so that, in passing each orifice, the air becomes a high velocity jet directed substantially tangentially of the drum, and wherein each chamber which intervenes between two successive orifices gradually increases in radial width from the discharge side of an orifice so that the air delivered from said orifice, is permitted to expand and thus lose velocity in moving through the chamber, each chamber decreasing abruptly in radial width adjacent to the receiving side of the next following orifice whereby the velocity of air, in leaving the chamber, is rapidly increased to form a jet.

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