

July 29, 1969

TAKUZO TOOKA ET AL

3,457,597

ROLLER DRAFTING SYSTEM FOR SPINNING MACHINERY

Filed Sept. 15, 1967

2 Sheets-Sheet 1

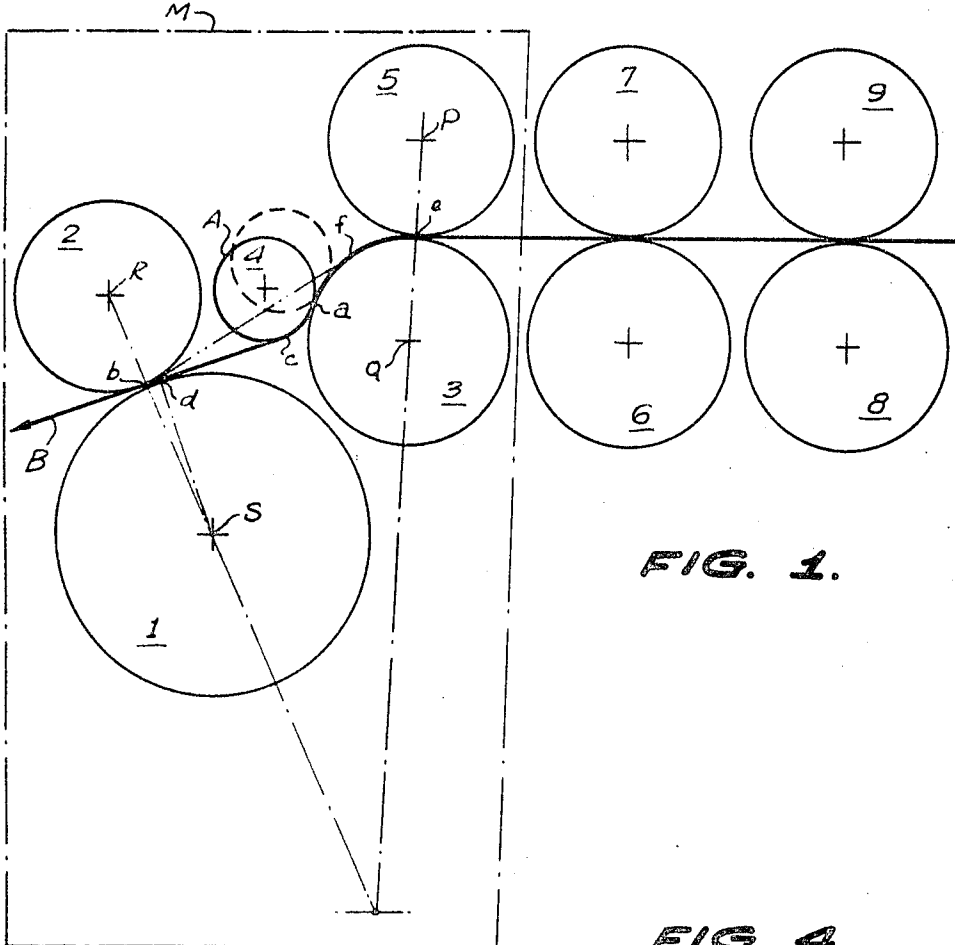


FIG. 1.

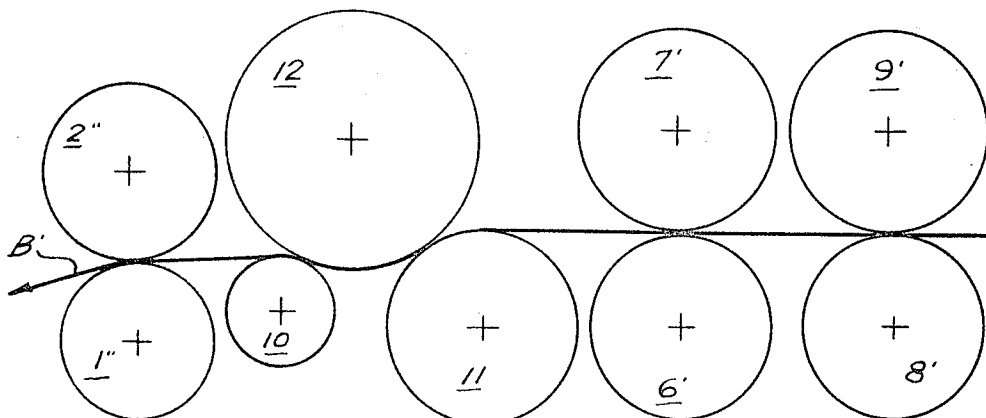


FIG. 4.

CONVENTIONAL ROLLER DRAFTING SYSTEM

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FIG. 2

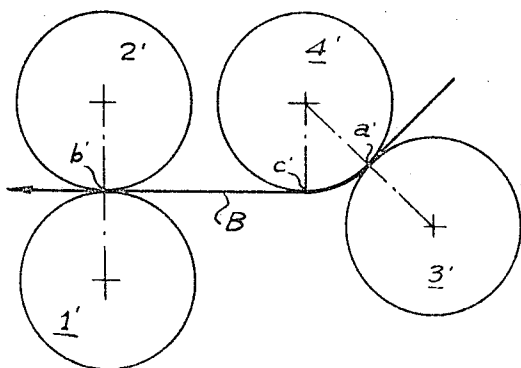


FIG. 3.

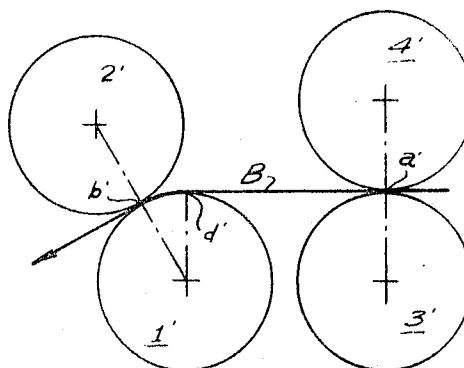


FIG. 5.

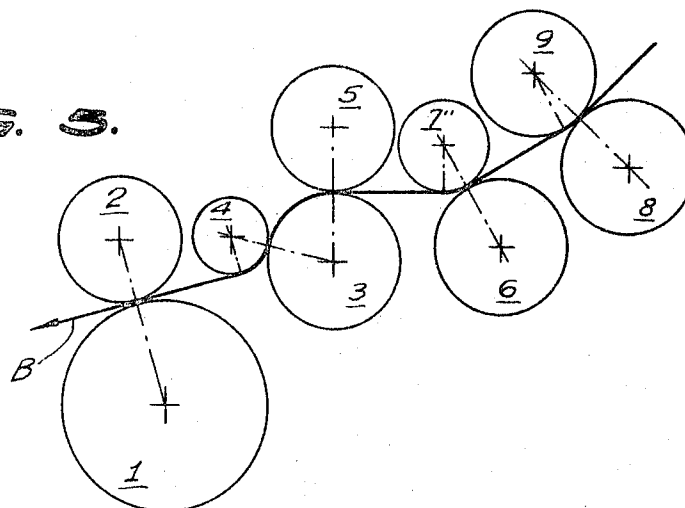
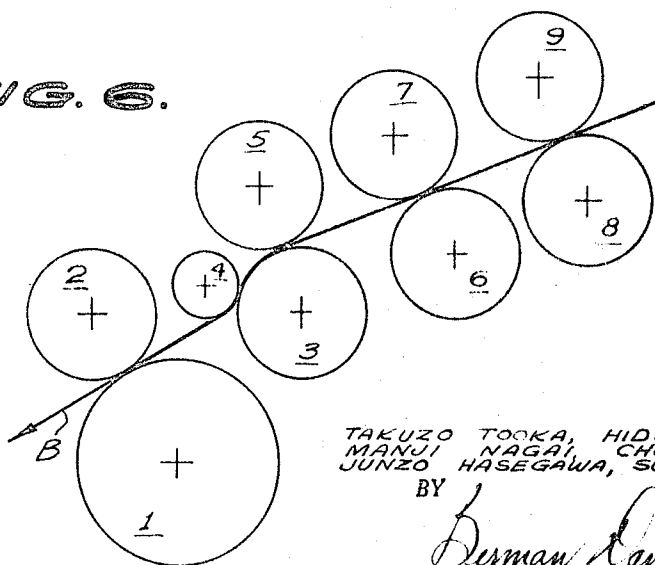


FIG. 6.



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ROLLER DRAFTING SYSTEM FOR SPINNING MACHINERY

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Int. Cl. D01h 5/74, 5/00

U.S. Cl. 19—258

3 Claims

ABSTRACT OF THE DISCLOSURE

A high-speed roller drafting system for a draw frame comprising a main drafting zone including five rollers, a front top roller in contact with and driven through a front bottom drive roller, a second and third top roller, respectively, in contact with and driven through a second bottom drive roller, the front top roller being smaller in diameter than the front bottom roller and the second top roller being smaller in diameter than each of the front top roller and the second bottom roller, said rollers of the main zone being so arranged that the extension of a straight line drawn from the center of the third top roller to the center of the second bottom roller intersects the extension of a straight line drawn from the center of the front top roller to the center of the front bottom roller, the nip between the second bottom roller and the second top roller being below the tangent drawn from the nip between the front top roller and the front bottom roller to the upper side of the second bottom roller, and a tangent drawn from the nip between the front top roller and the front bottom roller to the lower side of the second top roller being substantially perpendicular to the straight line connecting the centers of the front top roller and the front bottom roller.

This invention relates to an improved roller drafting system especially applicable to the main drafting zone for a drawframe, in the spinning of cotton, or staple fiber yarn.

The primary object of the invention is to provide a roller drafting system for spinning machinery capable of operating at very high speed without detriment to the quality of the sliver and so arranged as to avoid bearing and other drive problems.

Another object of the invention is to provide a roller drafting system in which a second top roller of smaller diameter than conventional is driven from a bottom drive roller rather than from a top drive roller as in conventional apparatus.

A further object of the invention is to provide a roller drafting system in which the curvilinear arc of fiber touch at the input side of the front draft zone is lengthened while the curvilinear arc of fiber touch at the output side of said zone is reduced for better drafting action.

Yet another object of the invention is to provide a roller drafting system in which the rollers are so positioned as to yield capability of adjustment of the free length of fiber in the front drafting zone.

The invention provides a roller drafting system having the following advantages:

(a) The system forms only a small drafting wave in the drafted material and the sliver does not deteriorate even if the material is drafted at a very high speed;

(b) the system facilitates the adjustment of the roller

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setting or the distance between the roller nips in the front drafting zone, when changing the drafted material;

(c) the system can be operated in a stable state because the forward direction of the delivery is inclined downwardly and because the adhesion, or the winding, of fibers on the rollers, is reduced;

(d) the system lends itself to easy initiation of operation;

(e) the system can be easily equipped with a sliver thickness regulator; and

(f) the system is of sturdy construction and durable under very high speed operation.

The novel features that are considered characteristic of the invention are set forth with particularity in the appended claims. The invention, itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of specific embodiments when read in connection with the accompanying drawings, wherein like reference characters indicate like parts throughout the several figures and in which:

FIG. 1 is a diagram illustrating a preferred embodiment of the invention,

FIGS. 2 and 3 are fragmentary diagrams illustrating technical principles used or applied to the invention,

FIG. 4 is a diagram showing a conventional roller drafting system for comparison with the invention, and

FIGS. 5 and 6 are diagrams similar to FIG. 1, but illustrating other preferred embodiments according to the invention.

Referring more particularly to the drawings, a preferred embodiment of the invention is diagrammed in FIG. 1 as comprising a roller drafting system for a draw-frame with a five over four roller arrangement, the construction, elements, drives, etc., being conventional except for the differences mentioned hereinafter. The four bottom rollers 1, 3, 6 and 8 are driven in a conventional manner from a driving shaft (not shown). The five top rollers 2, 4, 5, 7 and 9 are driven by friction from the bottom rollers. The main drafting zone M is composed of five rollers 2, 1, 4, 3 and 5 so arranged and proportioned that the front top roller 2 has a smaller diameter than the front bottom roller 1 and is in contact with and driven by friction through said front bottom roller; the second top roller 4 has a smaller diameter than each of the front top roller 2 and the second bottom roller 3 and is in contact with and driven by friction through said second bottom roller; the extension of a straight line PQ drawn from the center of rotation P of the third top roller 5 in the direction of and through the center of rotation Q of the second bottom roller 3 intersects the extension of the straight line element RS drawn from the center of rotation R of the front top roller 2 in the direction of and through the center of rotation S of the front bottom roller 1; the point of contact a between the second bottom roller 3 and the second top roller 4 is positioned below the tangent bf drawn from the point of contact b to the upper side of the second bottom roller 3; and the tangent bc drawn from the point of contact b to the lower side of the second top roller 4 is substantially perpendicular to the straight line RS which connects the center of rotation R of the front top roller 2 with the center of rotation S of the front bottom roller 1.

As shown in FIG. 1, the third and fourth top rollers 5 and 7 are in contact respectively with the second and third bottom rollers 3 and 6 and are driven by friction through said bottom rollers. The back top roller 9 is in contact with the back bottom roller 8 and is driven by friction through said back bottom roller. The arrow indicates the direction of flow of the sliver B.

In general, in order to raise the delivery speed of a drawframe, it is necessary to increase the surface speed of each roller. Especially, the surface speeds of the front rollers must be the highest of the drawframe rollers. To increase the delivery speed of a high speed drawframe from the normal speed 150 m./min. up to 500 m./min. with the same diameter (28 mm.), of the front bottom roller, it is necessary to increase the revolutions per minute of the front bottom roller, or driving roller, from 1,710 to 5,700 rpm. However, increase of the speed of driving rollers up to a very high rate causes various troubles in bearings and other driving parts.

In order to overcome this trouble, the diameter of the front bottom roller 1 is increased according to the invention, so that the delivery speed may be increased while the revolutions per minute are kept below a certain value. For example, when the diameter of the front bottom roller 1 is increased to 60 mm., and for a delivery speed of 500 M./min. it is only necessary to raise the speed of the front roller 1 to 2,660 rpm.

In a conventional roller drafting system, increasing the diameter of the front bottom roller necessitates wider roller setting, with the accompanying problem of formation of a larger drafting wave. In the invention, however, the proportioning and arrangement of the rollers, as described above, prevents formation of a larger drafting wave. The front top driven roller 2, being smaller, can rotate faster and withstand the higher revolutions per minute than the front bottom driving roller 1. Making the front top roller 2 smaller than the front bottom roller provides ample space for placement of the second top roller 4. Since the second top roller 4 is made smaller in diameter than the front top roller 2, said second top roller 4 can be installed in the space between the front bottom roller 1, the front top roller 2, and the second bottom roller 3, and the setting *ab* of the front drafting zone, namely, the fiber pass from the point of contact *a* between the rollers 4 and 3 on the input side to the point of contact *b* between the rollers 2 and 1 on the output side, can be considerably shortened, so that the formation of the drafting wave is not increased even though the diameter of the front bottom roller 1 has been increased.

In general, it is possible to improve the drafting action by placing the curvilinear fiber touch region on a roller up to the same order as in the case of employing aprons over drafting rollers. According to the invention, as indicated previously in the arrangement of rollers composing the main drafting region, the extension of the straight line PQ drawn from the center of the third top roller 5 in the direction of the center of the second bottom roller 3 intersects the extension of the straight line RS drawn from the center R of the front top roller 2 in the direction of the center of the front bottom roller 1, the point of contact *a* between the rollers 4 and 3 is placed below the tangent *bf* drawn from the point of contact *b* between the rollers 2 and 1 to the upper side of the second bottom roller 3, and the tangent *bc* drawn from the point of contact *b* between the rollers 2 and 1 to the lower side of the second top roller 4 is substantially perpendicular to the straight line RS. Therefore, the sliver B' is in curvilinear contact with the surface of the second top roller 4 in the arc *ac* at the input side of the front drafting zone, while the sliver B has no curvilinear contact at the output side of the front drafting zone, or has only a small curvilinear contact in the arc *bd* on the front bottom roller 1 or on the front top roller 2. In the front drafting zone having this inventive arrangement, better drafting action is attained with a smaller formation of drafting wave so that high quality sliver is produced even when the drawframe is operated at high speed. The second top roller 4 may be varied somewhat in position, as for example to occupy the broken line position of FIG. 1 without departing materially from the inventive concept and improved results.

For a better understanding of the theory of composing

the curvilinear contact region of sliver in drafting zone, the following detailed explanation is given.

FIG. 2 and FIG. 3 indicate theoretic roller systems drafting sliver B in the direction of the arrow. While the bottom rollers 1' and 3' are driven by a driving shaft, each of the top rollers 2' and 4' is in contact with either the bottom roller 1' or 3' and driven by friction through the roller 1' or 3' respectively.

In general, there are two modes of placing curvilinear arc of fiber contact on a roller. One is the mode in which the arc is placed at the input side of the drafting zone, namely, the zone of fiber passage from the point of contact *a'* between the rollers 4' and 3' at the input back side to the point of contact *b'* between the rollers 2' and 1' at the output front side as shown in FIG. 2, and the other is the mode in which the arc is placed at the output side as shown in FIG. 3. The present inventors have confirmed through tests that the curvilinear arc of contact *a'c'* at the input side as in FIG. 2 is considerably preferable over placing the curvilinear arc of contact *d'b'* at the output side as in FIG. 3.

When the curvilinear region of fiber touch along arc *a'c'* is in the input side, as shown in FIG. 2, the speed of a fiber, whose trailing end has left the nip point *a'* between the back rollers 4' and 3', and which is nipped by neither of two pairs of rollers, back rollers nor front rollers, is maintained at the surface speed of the back rollers 3' and 4' or so-called "low-speed," owing to a large interfiber friction at *a'c'*, until the leading end of the fiber reaches the nip point *b'* between the front rollers 2' and 1'. Therefore, the speed change, at which such a fiber is abruptly accelerated from the low-speed to the surface speed of the front rollers 1' and 2', or so-called "high-speed," concentrates sharply around a point near the nip point *b'*, resulting in drafting action and very little irregularity due to the drafting wave.

On the contrary, when the curvilinear region of fiber touch is placed at *d'b'* in the output side as shown in FIG. 3, a floating fiber, which is nipped by neither of the nip points *b'* nor *a'*, tends to be accelerated as soon as the leading end of the fiber reaches the curvilinear arc *d'b'*. In this case, the number of fibers touching the arc *d'b'* at a given time is smaller than the number of fibers touching the arc *a'c'*, so that it is indefinite at what point the fibers are accelerated; in other words, the high-speed fibers on the curvilinear arc *d'b'* are increased in number as well as speed, but most of the above-mentioned floating fibers tend to accelerate and run at high-speed when more fibers are nipped by the front nip point *b'*, while most of the floating fibers do not accelerate, but tend to run at low-speed when less fibers are nipped by the front nip point *b'*. Therefore, the FIG. 3 construction has the disadvantage that, the speed change points are distributed over a wider range, and the irregularity of the sliver is increased by the additional formation of the drafting wave.

Hence, the present invention contemplates that a curvilinear arc of fiber touch *ac* is placed at the input side of the front draft zone and the curvilinear arc of fiber touch *db* at the output side is diminished or kept very short so that better drafting action may be accomplished with less formation of drafting wave.

Other functions and advantages of the system arrangement according to the invention are described hereinafter. For example, tests have shown that the optimum roller setting is obtained by the adjustment of the free length *cd*, the most favorable free length being determined by UQL, the upper quartile length of the fibers in the drafted material. Therefore, when changing a drafted material to one of different staple length, the inventive system provides for adjustment of free length *cd* to maintain the above-mentioned conditions of fiber touch on the curvilinear arcs at both the input side and the output side of the front drafting zone, without any adjustment of the second bottom roller 3. This is done by making the second

top roller 4 adjustably movable from the solid line position of FIG. 1 to the broken line position in FIG. 1, for instance, while still maintaining its surface contact with the second bottom roller 3, and out of contact with any other rollers.

In the conventional system of FIG. 4 1'', 11, 6' and 8' are bottom rollers driven directly by a driving shaft; 2'', 12, 7' and 9' are top rollers which are driven by friction through the bottom rollers respectively. The arrow indicates the direction of flow of sliver B'. 10 is also a bottom roller. It may be either driven directly by a driving shaft or driven by friction through the top roller 12. The free length in FIG. 4 corresponding to *cd* in FIG. 1 can be adjusted by shifting the second bottom roller 10 backward or forward. This has the disadvantage that the adjusting range of the shift is small and the adjusting operation and machine maintenance are complicated and difficult because said roller 10 is a bottom roller placed between the bearing brackets of adjacent bottom rollers which are rigid and rather bulky.

By contrast in the inventive system of FIG. 1, the roller to be shifted for obtaining the optimum free length is the second top roller 4 in the driven roller side. Thus, the setting *ab* in the front drafting zone can be adjusted according to the staple length of the fiber material without shifting either bottom roller 1 or 3 in the driving roller side. Therefore, this arrangement provides a simple yet sturdy drafting system, is very easy to handle, and yields the advantage of rapid adjustability of settings for free length of fiber according to the mean staple length of the material being processed.

Tests have verified that the curvilinear fiber touch arc *ac* in the input side of a front drafting zone must be 6 mm. or more for the arc *ac* to function effectively, as explained above, while the curvilinear fiber touch arc *db* in the output side must be 4 mm. or less to avoid the explained disadvantage of said arc *db*. To obtain an arc *ac* of 6 mm. or more, it is preferable to increase the diameter of the second top roller 4 provided this is allowed by the spacing of the front bottom roller 1, the front top roller 2, the second bottom roller 3, and the third top roller 5 as well as the required free length adjustable range *cd*. It has also been found preferable by tests that the diameter of the second top roller 4 be more than 15 mm.

It is preferable to employ grooved metallic rollers as each the third bottom roller 6, the fourth top roller 7, the back bottom roller 8, and the back top roller 9 for the five over four roller drafting system on a super high speed and high draft drawframe according to the invention shown in FIG. 1. This is especially so as to the back bottom roller 8 and the back top roller 9 and to mesh one of them with the other so as to grip the sliver more firmly, and for better control of the sliver drafted.

In the embodiment shown in FIG. 1, the second bottom roller 3, the third bottom roller 6, and the back bottom roller 8 have equal diameters to make possible the convenience of their mutual exchange. This also applies to the third top roller 5, the fourth top roller 7 and the back top roller 9.

The direction of the tangent of the front bottom roller 1 and of the front top roller 2 at the point of contact *b* can be changed through a wide range to suit process demands, by swinging the assembly of the front bottom roller 1, the front top roller 2, and the second top roller 4 around the axis Q of the second bottom roller 3. The sliver from the roller drafting system is delivered through a coiler (not shown, but placed forwardly and downwardly) and then stored in a can. The sliver in the form of web as delivered between the front bottom roller 1 and the front top roller 2 runs in the direction of the tangent at the point of contact *b*. On a super high speed drawframe, the momentum of the running sliver is so large that it is not desirable, from the viewpoint of stability, to guide the sliver through the coiler which is offset from said tangent. The roller drafting system according to the

invention, therefore, improves the stability of the operation, because the direction of said tangent can be changed through a wide range without affecting the composition of the front drafting rollers.

Considering the initiation of the drafting of silver on a conventional four over five roller drafting system as in FIG. 4, when the silver is fed between the back bottom roller 8' and the back top roller 9', the fibers tend to flow forward and downward at an angle with the tangent drawn at the point of contact between the rollers 12 and 11 owing to the weight of the fibers. So that the fibers may be deposited between the second bottom roller 10 and the third bottom roller 11, it becomes necessary to remove the second top roller 12, to guide the deposited fibers to the nip between the front bottom roller 1'' and the front top roller 2'', and then to re-start the machine. Thus, the initiation, or starting operation, involves two steps, with resulting delay and unsmoothness of a sliver when new slivers are lapped in.

On the contrary, on the roller drafting system according to the invention as shown in FIG. 1, the locus of the fibers ejected from the third top roller 5 deviates downward from the tangent of the third top roller 5 and the second bottom roller 3 at the point of contact *e* due to the gravitational force and reaches the surface of the second top roller 4 along the surface of the second bottom roller 3. Although the fibers ejected from the second top roller 4 also tend to flow downward, the fibers are carried on the surface of the front bottom roller 1 whose upper surface is running forward and then nipped by the front top roller 2. Thus, in the initiation of the drafting operation, the fibers automatically reach the nip between the front bottom roller 1 and the front top roller 2, simply by supplying the fibers B to the nip between the back bottom roller 8 and the back top roller 9. It is an advantageous feature of this invention that the initiation is performed very smoothly in such a way, and with only one step.

The tendency toward fiber adhesive, or winding, on the front bottom roller is a big problem particularly in high speed operations. The use of the front bottom roller 1 with a larger than conventional diameter in the invention is very effective for preventing such trouble.

Most drafting systems utilize a sliver thickness regulator, the thickness being controlled by varying the revolutions per minute of the front bottom roller according to the thickness detected. In a super high speed drawframe, the revolutions per minute of the front bottom roller must be higher than conventional. Therefore, to increase the speed of conventional machines the regulating systems of the front rollers should be reformed for higher revolutions per minute, but this is rather difficult. In the present invention, it is not necessary to increase the revolutions per minute of the front bottom roller 1 up to as high a level, even for a super high speed operation of the drawframe, because of the larger diameter of said roller. Thus, the regulating system may be attached to the drawframe without major reconstruction. This is also an advantage of the invention.

In the second embodiment illustrated in FIG. 5, the fourth top roller 7'' is reduced in diameter and the center of said roller 7'' is placed more forward, while the center of the third bottom roller 6 is placed back of the center of the fourth top roller 7''. The back bottom roller 8 is placed higher than the same roller 8 shown in FIG. 1, and the center of the back top roller 9 is placed in front of the center of the back bottom roller 8. With this arrangement a curvilinear fiber touch arc is obtained in the input side with no or very little curvilinear fiber touch arc in the output side of both the intermediate drafting zone and the back drafting zone, or, if desired, either in the former or in the latter. The intermediate drafting zone is composed of the rollers 5 and 3 and the rollers 7'' and 6. The back drafting zone is composed of the rollers 7'' and 6 and the back rollers 9 and 8. With the de-

scribed arrangement it is possible to reduce the free length of each drafting zone according to the UQL of the fiber material without reducing the diameter of each bottom roller to attain the draft control with little formation of drafting wave. Therefore, it is possible to increase the total draft of the roller drafting system by increasing the draft in each drafting zone and to obtain a product having less irregularity due to the drafting wave. It is further preferable to make the back top roller 9 larger than the fourth top roller 7" to nip the sliver more firmly at the inlet of the system. It will be noted that the described arrangement is such that an extension of the straight line drawn from the center of the third bottom roller 6 to the center of the fourth top roller 7" intersects the extension of the straight line drawn from the center of the back bottom roller 8 to the center of the back top roller 9" and the tangent from the nip of rollers 7" and 6 to the underside of roller 9 is substantially perpendicular to said first line as in the main drafting zone described for FIG. 1.

In the third embodiment illustrated in FIG. 6, the system is so arranged that the intermediate and back drafting zones are inclined upwardly toward the rear, the back bottom roller 8 being placed slightly above the third bottom roller. This arrangement is used when required by space and other factors, and there is no difference in result or principle from the FIG. 1 embodiment. Thus, the drafting zone back of the third bottom roller 6 and the drafting zone in front of the second bottom roller 3 can be relatively inclined through an arbitrary angle with considerable freedom, without changing the composition of the drafting zone between rollers 6 and 3. It is thus a feature of the invention that each drafting zone can be relatively inclined without affecting the drafting action of other drafting zones.

Although certain specific embodiments of the invention have been shown and described, it is obvious that many modifications thereof are possible. The invention, therefore, is not to be restricted except insofar as is necessitated by the prior art and by the spirit of the appended claims.

What is claimed is:

1. A roller drafting system for spinning machinery comprising a main drafting zone including a front top roller in contact with and driven through a front bottom drive roller, and second and third top rollers respectively in contact with and driven through a second bottom drive roller, and an intermediate drafting zone including said second bottom and third top rollers, and a fourth top roller in contact with and driven by a third bottom drive roller, the front top roller being smaller in diameter than the front bottom roller and the second top roller being smaller in diameter than each of the front top roller and the second bottom roller, the second top roller being adjustably movable along the surface of the second bottom

roller, said rollers of the main zone being so arranged that the extension of a straight line drawn from the center of the third top roller to the center of the second bottom roller intersects the extension of a straight line drawn from the center of the front top roller to the center of the front bottom roller, the point of contact between the second bottom roller and the second top roller being below the tangent drawn from the point of contact between the front top roller and the front bottom roller to the upper side of the second bottom roller so that the length of the arc on the second top roller from the point of its contact with the second bottom roller to the point of its contact with the common tangent of the lower surface of the second top roller and the upper surface of the front bottom roller is at least 6 mm., a tangent drawn from the point of contact between the front top roller and the front bottom roller to the lower side of the second top roller being substantially perpendicular to the straight line connecting the centers of the front top roller and the front bottom roller so that the length of the arc on the front bottom roller from the point of contact between the front bottom roller and the said common tangent to the point of contact between the front bottom roller and the front top roller is no greater than 4 mm., and a tangent drawn from the point of contact between the third top roller and the second bottom roller to the lower side of the fourth top roller is substantially perpendicular to the straight line connecting the centers of the third top roller and the second bottom roller so that the length of curvilinear arc of fiber touch on each of the second bottom roller and third top roller on the output side of said intermediate draft zone is no greater than 4 mm.

2. A roller drafting system as claimed in claim 1, wherein said fourth top roller has a smaller diameter than the third bottom roller and is placed forward thereof.

3. A roller drafting system as claimed in claim 1, wherein the diameter of said second top roller is greater than 15 mm.

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