

[54] **YARN TWIST CONTROL APPARATUS FOR ELECTROSTATIC SPINNER**

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Related U.S. Application Data

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[51] Int. Cl. D01h 1/12

[58] Field of Search. 57/58.89-58.95,
57/5, 6, 51, 51.6

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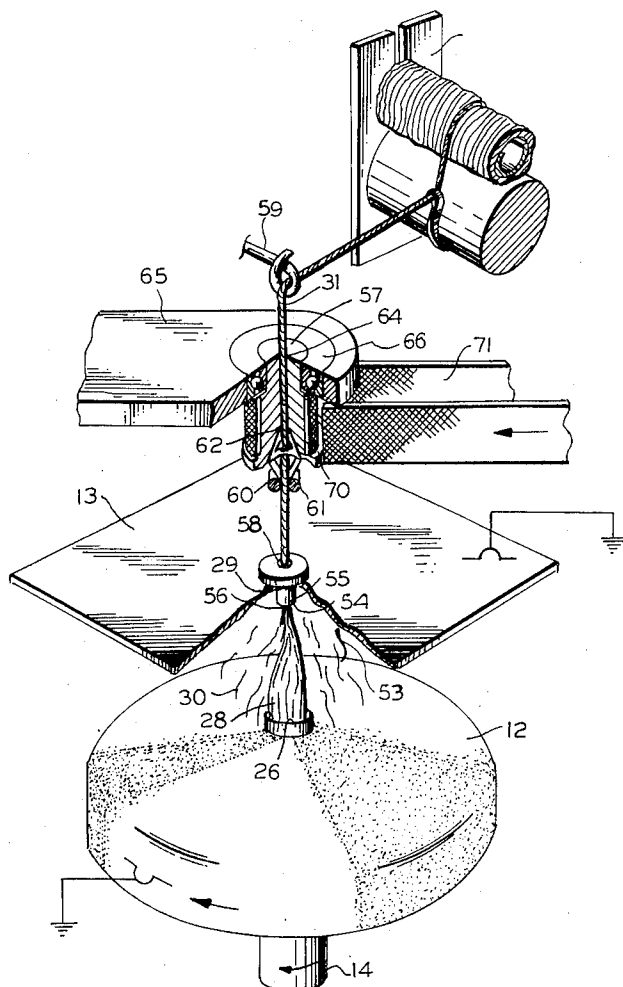
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[57] ABSTRACT

This invention relates to an apparatus for controlling the amount of twist inserted into yarns in the fiber assembly area of an electrostatic yarn spinning apparatus, providing a means whereby any portion of the final twist can be inserted as fibers are being consolidated for yarn formation.

The invention also provides a means for effecting untwist to a coring yarn prior to electrostatic spinning of surface fibers circumferentially about said coring yarn and allowing return of normal twist in the coring yarn to interlock spun surface fibers to produce a mechanically bonded core yarn of dissimilar materials.

7 Claims, 3 Drawing Figures



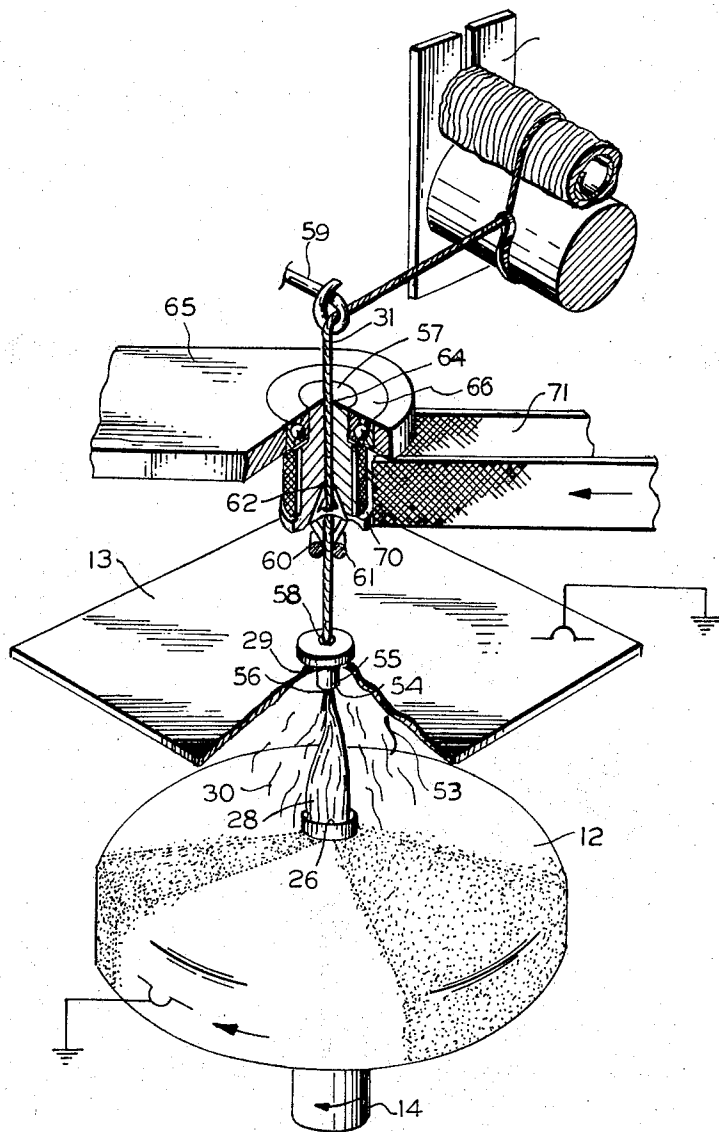


FIG. 1

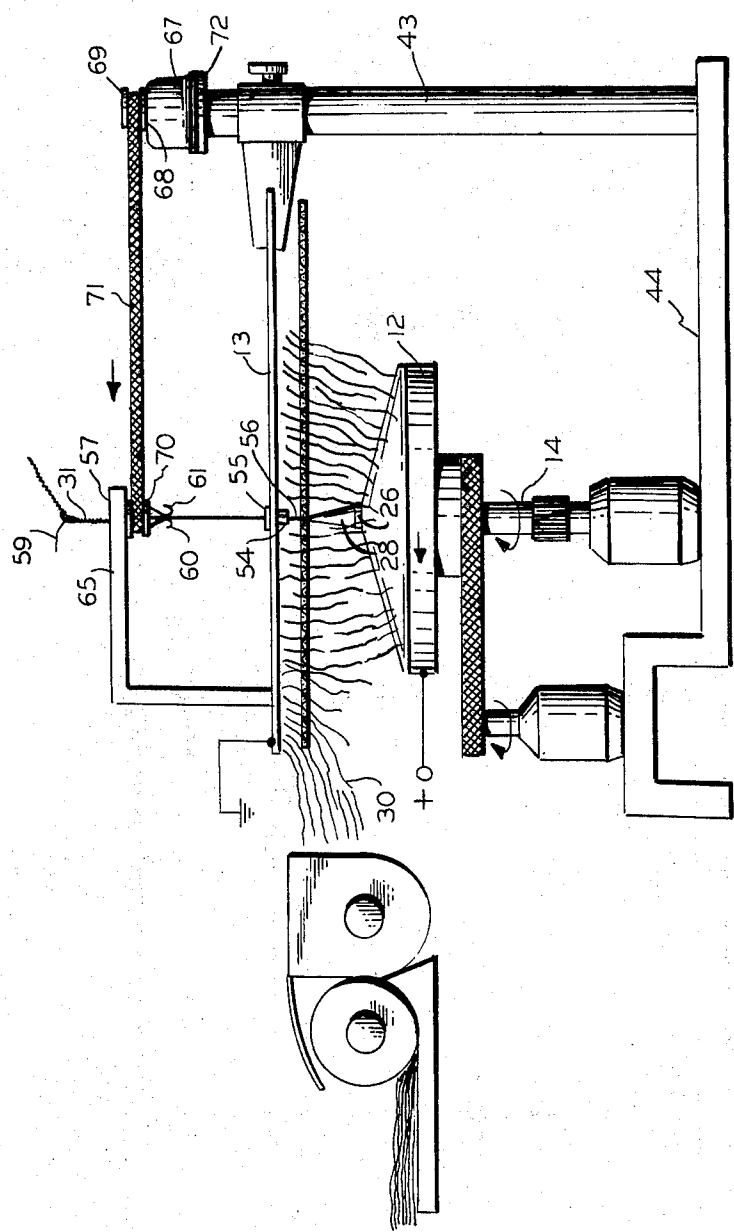


FIG. 2

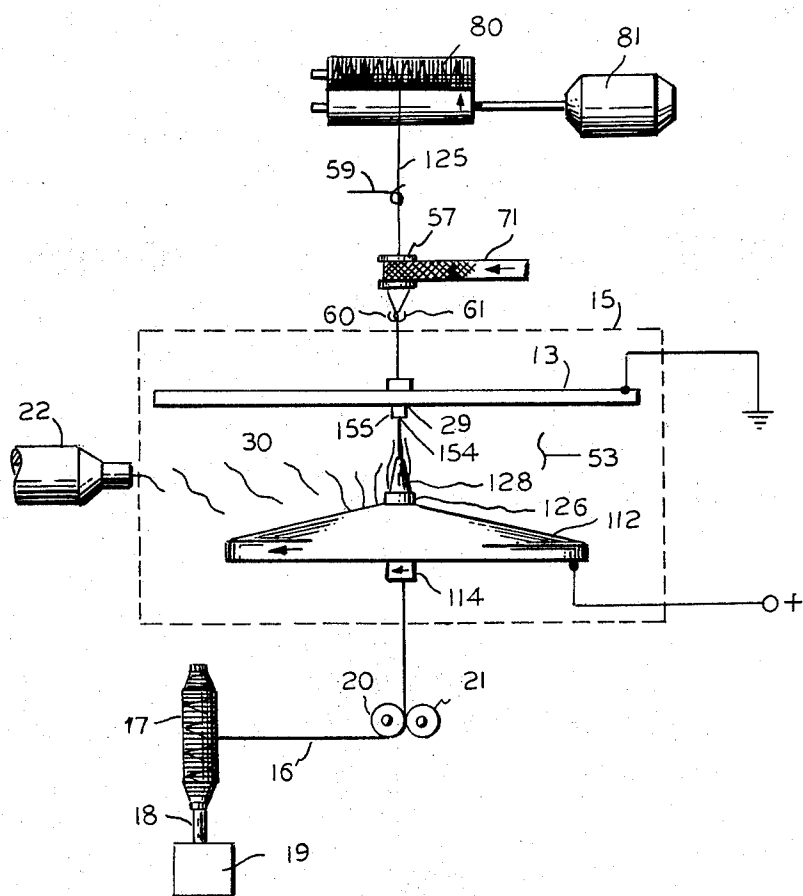


FIG. 3

YARN TWIST CONTROL APPARATUS FOR ELECTROSTATIC SPINNER

This is a continuation-in-part of application Ser. No. 132,952, filed Apr. 12, 1971, now U.S. Pat. No. 3,696,603, entitled Electrostatic Fiber Collecting and Yarn Spinning Apparatus; and an improvement over application Ser. No. 132,953, filed Apr. 12, 1971, now U.S. Pat. No. 3,696,600, entitled Apparatus for Producing Core Yarn. This invention relates to an improvement over the above noted patent applications.

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

The instant invention discloses a method and apparatus for controlling the amount of twist inserted into yarn at the fiber assembly area of an electrostatic yarn spinning apparatus.

More specifically, the invention discloses a method and apparatus whereby any portion of the final twist can be inserted as the fibers are being assembled and consolidated for yarn formation.

Still more specifically, the invention provides a means for inserting final twist into open-end spun yarn after fiber assemblage, as done in conventional ring spinning systems.

The invention also discloses a method and apparatus for effecting partial or complete untwist to a coring yarn prior to spinning and attachment of peripheral surface fibers about said coring yarn.

Furthermore, the invention discloses a method and apparatus for allowing return of normal twist in the coring yarn to interlock and tightly hold spun surface fibers, producing a mechanically bonded core yarn of similar or dissimilar materials.

In ring spinning systems final twist is inserted after fibers have been aligned and assembled into a strand. In open-end spinning systems fibers are continually added during twist insertion, resulting in poor fiber alignment, a variance of fiber twist throughout the cross-section of the yarn, and poor interfiber frictional relationships.

These inherent disadvantages are chiefly responsible for open-end yarn being considered inferior to ring spun yarn.

An object of this invention is to improve the overall characteristics of open-end spun yarn by controlling the amount of twist inserted into yarn in the fiber assembly area.

Another object of the invention is to provide a means whereby any portion of the final twist can be inserted as fibers are being assembled and consolidated for yarn formation.

Another object of the invention is to eliminate loss of yarn twist because of fiber slippage on the spindle due to high twist in the assembly area.

Another object of the invention is to provide a means for inserting final twist into the yarn after the fibers have been assembled, as done in conventional ring spinning systems.

Another object of this invention is to increase fiber alignment and thus improve fiber interfriictional relationship in open-end spun yarn by permitting the fibers to assemble in alignment before inserting final twist.

Another object of the invention is to eliminate a variance of fiber twist throughout the cross-section of open-end spun yarn.

Another object of this invention is to provide a means for effecting untwist in a coring yarn prior to electrostatic spinning of surface fibers circumferentially about said coring yarn and allowing return of normal twist in the coring yarn to interlock spun surface fibers to produce a mechanically bonded core yarn of dissimilar materials.

The unique principle of this invention employs a yarn twisting means axially aligned with, but separated from, a spindle element of an open-end spinning system such as, the non-conducting spindle projection disclosed in application Ser. No. 132,952.

Said yarn holding and twisting element revolving at controlled different speeds than the spindle element, employs a frictional or mechanical gripping means with sufficient force to hold and yet allow yarn passage therethrough.

The amount of twist inserted into the partially formed yarn at the spindle element of the open-end spinning system is directly related to the speed differential between said spindle element and yarn holding and twisting element.

Final twist is inserted into the yarn between said yarn holding and twisting element and the yarn winding means.

Also the unique principle of this invention employs a yarn twisting means axially aligned with, but separated from, an axially cored spindle element of an open-end spinning system, such as the non-conducting cored spindle projection disclosed in application Ser. No. 132,953.

Said yarn holding and twisting element revolving at controlled different speeds than the cored spindle element, employing a frictional or mechanical gripping means with sufficient force to hold and yet allow yarn passage therethrough effects partial or complete untwist to a coring yarn prior to spinning and attachment of peripheral surface fibers about and within said coring yarn. Upon passing through the holding and twisting means normal twist in the coring yarn returns to interlock and tightly hold spun surface fibers, producing a mechanically bonded core yarn.

Further objects and advantages of the invention will be apparent from the following specifications, drawings, and claims set forth herein.

In the drawings:

FIG. 1 is a three dimensional view of the invention with a partial view of the electrostatic yarn spinning apparatus. Portions are broken away to show internal construction.

FIG. 2 is a schematic view of the invention and the electrostatic fiber collector and yarn spinning apparatus with a fiber feeding device.

FIG. 3 is a schematic view of the invention and the apparatus for producing a core yarn.

Referring to our drawings, FIGS. 1 and 2 depict an embodiment of the invention utilized with the Electrostatic Fiber Collector and Yarn Spinning Apparatus of application Ser. No. 132,952 in which the rotating energized conic electrode 12 and the grounded stationary plate electrode 13 form and sustain an electrostatic field 53. Fibers 30, upon entering the electrostatic field 53 are aligned parallel to the lines of force and are rapidly transported, individually and uniformly to rotating

centrally located, knife-edge ring 26 and the conical, non-conducting spindle element 28 of spindle 14 by the interaction of electrostatic and mechanical forces, as disclosed in application Ser. No. 132,952.

Maximum electrostatic field intensity is between the conducting circular knife-edge ring 26 of spindle 14 and the projected extremity 54 of conducting tubular projection 55, fitted into opening 29 of flat plate electrode 13. Individualized fibers 30 are collected and held aligned in circular array in this region of highest field intensity as a portion of the final twist is being inserted into the partially formed yarn 56 by conical spindle element 28.

The amount of final twist inserted into partially formed yarn 56 is controlled by the difference in rotational speeds of the twist control spindle 57 and the conical spindle element 28.

Twist control spindle 57, by means of its leaf spring yarn grippers 60 and 61, holds partially formed yarn 56 with sufficient force to impart twist and allow passage of yarn 56 therethrough as it rotates. Spindle 57 has an axially aligned opening 62 sufficiently large to allow free passage of partially formed yarn 56 as it is being transformed into wholly formed yarn 31. Partially formed yarn 56 with a minimum of twist is withdrawn from spindle element 28 by conventional yarn winder 63.

Partially formed yarn 56 passes through axially aligned yarn passage 58 of tubular projection 55 to yarn grippers 60 and 61 of twist control spindle 57. It is between yarn grippers 60 and 61 and yarn winder 62 that final twist is inserted into partially formed yarn 56, and it is within these limits that yarn 56 is transformed into its final formation of wholly formed yarn 31.

To eliminate excessive side friction on inner walls 64 of opening 62 of twist control spindle 57, a guide 59 is employed to direct the yarn 31 onto the conventional winder 63.

Twist control spindle 57 is rotatably mounted axially and radially supported by member 65, through bearing 66 independently driven by variable speed motor 67 through motor shaft 68, pulleys 69 and 70, and non-conducting belt 71.

Member 65 is attached to plate electrode 13.

Motor 67 and motor base 72 are attached to support rod 43 of base 44.

If the twist control spindle 57 equals, that is, rotates at a speed equal to the rotational speed of the spindle element 28, then zero twist is inserted into the partially formed yarn 56, and all the final twist is inserted into the yarn 31 between the yarn grippers 60 and 61 and winder 63.

If the twist control spindle 57 lags, that is, rotates at a speed less than the rotational speed of the spindle element 28, then a portion of the final twist is inserted into the partially formed yarn 56. The amount of lag, that is, the difference in rotational speed of the twist control spindle 57 and the spindle element 28 determines the amount of twist inserted into the partially formed yarn 56. With the twist control spindle 57 rotating at 90 percent of the rotational speed of the spindle element 28; 10 percent of the final twist will be inserted into the partially formed yarn 56, and the remaining 90 percent will be inserted in yarn 31 between the grippers 60 and 61 and yarn winder 63.

If the twist control spindle 57 leads, that is, rotates at a speed faster than the rotational speed of the spindle

element 28, then twist in the opposite direction from the final twist will be inserted into the partially formed yarn 56. The amount of opposite twist inserted into the partially formed yarn 56 is determined by the difference between the rotational speed of the twist control spindle 57 and the rotational speed of the spindle element 28, i.e., with the twist control spindle 57 rotating at 110 percent of the speed of the spindle element 28, 10 percent of the final twist will be inserted in the opposite direction, into the partially formed yarn 56. The opposite twist inserted into the partially formed yarn 56 is removed, that is, cancelled in passing through the twist control spindle 57 and all 100 percent of the final twist is inserted into yarn 31 between yarn grippers 60 and 61 and yarn winder 63.

By allowing only a small amount of twist insertion between yarn grippers 60 and 61 and the apex of conic spindle element 28, a continuous fiber parallelization can be maintained in the yarn formation area and subsequently throughout initial fiber assemblage into yarn 31.

FIG. 3 schematically illustrates the yarn twist control apparatus with an embodiment for producing a core yarn as disclosed in application Ser. No. 132,953 in which a coring yarn 16 of any type staple fiber or filament of supply package 17 on spindle 18 is rotatably mounted on any conventional braking means such as frictional brake 19. Coring yarn 16 is fed between rotatably mounted feed rolls 20 and 21 in bearings not shown, into electrostatic fiber collecting and yarn spinning apparatus 15 of copending Patent Application, Ser. No. 132,952. Spindle element 128 and spindle 114 of unit 15 is modified by relocation of drive and providing an axial hole in each to permit coring yarn 16 to pass freely through center of rotation of spindle 114, and non-conducting spindle element 128.

Individual surfacing fibers 30 from any conventional source not shown are fed from duct 22 into electrostatic field 53 of apparatus 15. Said fibers 30 upon entering the electrostatic field 53 are aligned parallel to the lines of force and are rapidly transported, individually and uniformly to rotating, centrally located knife-edge ring 126 and the conical non-conducting spindle element 128 of spindle 114 by the interaction of the electrostatic and mechanical forces as disclosed in application Ser. No. 132,952.

Maximum electrostatic field intensity is between the conducting circular knife-edge ring 126 of spindle 114 and the extremity 154 of conducting tubular projection 155, fitted into opening 29 of plate electrode 13.

Individualized surfacing fibers 30 are collected and held aligned in circular array in this region of highest field intensity as a portion of the final twist is being inserted into the surfacing fibers 30 circumferentially about the coring yarn 16, as it traverses the zone between the tip of conic spindle element 128 and the projected extremity 154 of tubular projection 155.

Said coring yarn 16 enveloped by surfacing fibers 30, passes through grippers 60 and 61 and twist control spindle 57, through yarn 59, and it is wound onto any type package common to the art such as cheese 80. Said cheese 80 is driven by any conventional variable speed drive such as variable speed motor 81.

Between grippers 60 and 61 of twist control spindle 57 and feed rolls 20 and 21, the coring yarn 16 is untwisted to any degree desired by regulation of the rotational speed of the twist control spindle 57.

Upon passing through grippers 60 and 61 of twist control spindle 57, the original twist of core yarn 16, enveloped by partially twisted surface fibers 30, simultaneously returns as the remainder of the final twist is inserted into the partially twisted surface fibers 30, thus creating a mechanical bond by interlocking the surface fibers 30 into the twist of coring yarn 16. For example, with the apparatus producing core yarn 125 at the rate of 2,000 inches/minute and using a coring yarn 16 with 15 turns of twist/inch, 50 percent of said twist will be removed from said yarn 16 between grippers 60 and 61 and rolls 20 and 21 when twist control spindle 57 is rotated at 15,000 rpm in the direction for untwisting said coring yarn 16.

When conical spindle element 128 is rotated at a speed of 30,000 rpm in the same direction as twist control spindle 57, 50 percent of the final twist of surface fibers 30 sheathing core yarn 125 will be inserted between grippers 60 and 61 and conical spindle element 28.

As the coring yarn 16, enveloped by surfacing fibers 30, passes through grippers 60 and 61, the final 50 percent of the twist for the surfacing fibers 30, and the coring yarn 16 is inserted, thus forming the core yarn 125.

The twist control element 57 described in this disclosure is not restricted to the design depicted. It may be of any operable type common to the art, encompassing friction, mechanical, centrifugal means, or any combination thereof.

We claim:

1. A fiber collecting and yarn spinning apparatus with a rotary twist control element assembly comprising:

a. a stationary electrode element with a tubular projection, a rotary electrode element, means adapted to establish and maintain an electrostatic potential gradient between the electrode elements, incorporating fiber collecting and fiber twisting component, a spindle element assembly, a rotary twist control element assembly, a first electrically isolated driving means for turning the rotary electrode element, a second isolated driving means for turning the spindle element assembly, a third isolated driving means for turning the twist control element assembly, associated supporting and positioning means for the several elements and associated electrical circuitry for establishing and maintaining electrostatic potential gradient;

b. said spindle element assembly comprising means defining an elongated cylindrical member with one end integral said second driving means, and the other end terminating in nonconducting means defining a smooth, cone shaped fiber twisting component, a first central portion immediately adjacent to the fiber twisting component incorporating conductive means defining an integral fiber collecting ring concentrically encompassing and extending radially from the base of the fiber twisting component, said ring terminating axially toward the free end of the fiber twisting component in a circular knife edge, a second central portion immediately adjacent said ring incorporating journal and bearing means adapted to support axially and radially the rotary electrode element;

c. the rotary electrode element comprising means defining a generally disk shaped member incorporating electrode surface of conducting material, drive means integral said disk shaped member separated

encumberably from the electrode surface, said rotary electrode element mounted with associated journal and bearing means on the spindle element assembly, rotatably therearound in a plane normal to the axis thereof in the area adjacent the ring defining means of the spindle assembly and located with the circular knife edge of the ring extended beyond the electrode surface;

d. the stationary electrode element comprising means defining a regular plate member incorporating a smooth conductive electrode surface at least equivalent to the area of the rotatable electrode surface, said plate member pierced with a centrally located circular opening of diameter sufficient for snug insertion of tubular element projected toward but separated from fiber twisting component, said tubular element having an inside diameter sufficient to pass the twisting congruent with clearance;

e. the rotary twist control element assembly comprising a yarn twisting element with means to impart twist to and allow passage of yarn, said element rotated in same plane and direction as spindle element assembly to control amount of twist inserted into said yarn between said yarn twisting element and spindle element assembly, drive means integral said yarn twisting element, said yarn twisting element axially aligned with said spindle element assembly, mounted with associated journal and bearing means between stationary electrode and yarn winder;

f. the first driving means adapted to turn the rotatable electrode element at a speed sufficient to insure uniform distribution of the fibers across the electrode and insure a rate of fiber transport adequate for yarn production;

g. the second driving means adapted to turn the spindle element assembly independently of the rotatable electrode element;

h. the third independent driving means adapted to turn the rotary twist control element assembly.

i. the supporting and positioning means adapted to support and maintain the electrode surface of the rotatable electrode element in a facing position adjacent the electrode surface of the stationary electrode element, spaced adjustably from the circular knife edge of the fiber collecting ring over a range coincident the length of the fibers being processed.

2. A fiber collecting and yarn spinning apparatus with a rotary twist control element assembly comprising:

a. a stationary electrode element with a tubular projection, a rotary electrode element, means adapted to establish and maintain an electrostatic potential gradient between the electrode elements, incorporating fiber collecting and fiber twisting component, a spindle element assembly, a rotary twist control element assembly, a first electrically isolated driving means for turning the rotary electrode element, a second isolated driving means for turning the spindle element assembly, a third isolated driving means for turning the twist control element assembly, associated supporting and positioning means for the several elements and associated electrical circuitry for establishing and maintaining electrostatic potential gradient;

b. said spindle element assembly comprising means defining an elongated cylindrical member with one end integral said driving means, and the other end

- terminating in nonconducting means defining a smooth cylindrical shaped fiber twisting component, with a passage beginning on its longitudinal periphery and terminating at the axial center of the free end of said fiber twisting component, a first central portion immediately adjacent the fiber twisting component incorporating conductive means defining an integral fiber collecting ring concentrically encompassing and extending radially from the base of the fiber twisting component, said ring terminating axially toward the free end of the fiber twisting component in a circular knife edge, a second central portion immediately adjacent said ring incorporating journal and bearing means adapted to support axially and radially the rotary electrode element;
- c. the rotary electrode element comprising means defining a generally disk shaped member incorporating electrode surface of conducting material, drive means integral said disk shaped member separated encumberably from the electrode surface, said rotary electrode element mounted with associated journal and bearing means on the spindle element assembly, rotatable therearound in a plane normal to the axis thereof in the area adjacent the ring defining means of the spindle assembly and located with the circular knife edge of the ring extended beyond the electrode surface;
- d. the stationary electrode element comprising means defining a regular plate member incorporating a smooth conductive electrode surface at least equivalent to the area of the rotatable electrode surface, said plate member pierced with a centrally located circular opening of diameter sufficient for snug insertion of tubular element projected toward but separated from fiber twisting component, said tubular element having an inside diameter sufficient to pass the twisting congruent with clearance;
- e. the rotary twist control element assembly comprising a yarn twisting element with means to impart twist to and allow passage of yarn, said element rotated in same plane and direction as spindle element assembly to control amount of twist inserted into said yarn between said yarn twisting element and spindle element assembly, drive means integral said yarn twisting element, said yarn twisting element axially aligned with said spindle element assembly, mounted with associated journal and bearing means between stationary electrode and yarn winder;
- f. the first driving means adapted to turn the rotatable electrode element at a speed sufficient to insure uniform distribution of the fibers across the electrode and insure a rate of fiber transport adequate for yarn production;
- g. the second driving means adapted to turn the spindle element assembly independently of the rotatable electrode element;
- h. the third independent driving means adapted to turn the rotary twist control element assembly.
- i. the supporting and positioning means adapted to support and maintain the electrode surface of the rotatable electrode element in a facing position adjacent the electrode surface of the stationary electrode element, spaced adjustably from the circular knife edge of the fiber collecting ring over a range coincident the length of the fibers being processed.

3. A fiber collecting and yarn spinning apparatus with a rotary twist control element assembly comprising:
- a. a stationary electrode element with a tubular projection, a rotary electrode element, means adapted to establish and maintain an electrostatic potential gradient between the electrode elements, incorporating fiber collecting and fiber twisting component, a spindle element assembly, a rotary twist control element assembly, a first electrically isolated driving means for turning the rotary electrode element, a second isolated driving means for turning the spindle element assembly, a third isolated driving means for turning the twist control element assembly, associated supporting and positioning means for the several elements and associated electrical circuitry for establishing and maintaining electrostatic potential gradient;
- b. said spindle element assembly comprising means defining elongated cylindrical member with one end integral said second driving means and the other end terminating in nonconducting means defining a smooth rod-shaped fiber twisting component with its free end terminated by an elliptically shaped disk with directly opposed hook-like appendages adjacent to and extending beyond the tips of the long axis of elliptical disk, said disk extending beyond periphery of said cylindrical spindle element, a first central portion immediately adjacent the fiber twisting component incorporating conductive means defining an integral fiber collecting ring concentrically encompassing and extending radially from the base of the fiber twisting component, said ring terminating axially toward the free end of the fiber twisting component in a circular knife edge, a second central portion immediately adjacent said ring incorporating journal and bearing means adapted to support axially and radially the rotary electrode element;
- c. the rotary electrode element comprising means defining a generally disk shaped member incorporating electrode surface of conducting material, drive means integral said disk shaped member separated encumberably from the electrode surface, said rotary electrode element mounted with associated journal and bearing means on the spindle element assembly, rotatable therearound in a plane normal to the axis thereof in the area adjacent the ring defining means of the spindle assembly and located with the circular knife edge of the ring extended beyond the electrode surface;
- d. the stationary electrode element comprising means defining a regular plate member incorporating a smooth conductive electrode surface at least equivalent to the area of the rotatable electrode surface, said plate member pierced with a centrally located circular opening of diameter sufficient for snug insertion of tubular element projected toward but separated from fiber twisting component, said tubular element having an inside diameter sufficient to pass the twisting congruent with clearance;
- e. the rotary twist control element assembly comprising a yarn twisting element with means to impart twist to and allow passage of yarn, said element rotated in same plane and direction as spindle element assembly to control amount of twist inserted into said yarn between said yarn twisting element and spindle element assembly, drive means integral

said yarn twisting element, said yarn twisting element axially aligned with said spindle element assembly, mounted with associated journal and bearing means between stationary electrode and yarn winder;

- f. the first driving means adapted to turn the rotatable electrode element at a speed sufficient to insure uniform distribution of the fibers across the electrode and insure a rate of fiber transport adequate for yarn production;
 - g. the second driving means adapted to turn the spindle element assembly independently of the rotatable electrode element;
 - h. the third independent driving means adapted to turn the rotary twist control element assembly.
 - i. the supporting and positioning means adapted to support and maintain the electrode surface of the rotatable electrode element in a facing position adjacent the electrode surface of the stationary electrode element, spaced adjustably from the circular knife edge of the fiber collecting ring over a range coincident the length of the fibers being processed.
4. An apparatus with a rotary twist control element assembly for peripherally surfacing a coring yarn with individual fibers to produce a core yarn with a bulky appearance which comprises:
- a. a stationary electrode element with a tubular projection, a rotary electrode element, means adapted to establish and maintain an electrostatic potential gradient between the electrode elements, a spindle element assembly, a rotary twist control element assembly, and a coring yarn assembly, a first isolated driving means for turning the rotary electrode element, a second isolated driving means for turning the spindle element assembly, a third isolated driving means for turning the twist control element assembly, a fourth isolated driving means for turning the coring yarn assembly, associated supporting and positioning means for the several elements and associated electrical circuitry for establishing and maintaining the electrostatic potential gradient;
 - b. said spindle element assembly comprising means defining an elongated cylindrical member pierced with a centrally located circular opening of diameter sufficient to pass the coring yarn with clearance; with one end integral said second driving means and the other end terminating in nonconducting means defining a smooth, centrally pierced cone-shaped fiber twisting component, a first central portion immediately adjacent the fiber twisting component incorporating conductive means defining an integral fiber collecting ring concentrically encompassing and extending radially from the base of the fiber twisting component, said ring terminating axially toward the free end of the fiber twisting component in a circular knife edge, a second central portion immediately adjacent said ring incorporating journal and bearing means adapted to support axially and radially the rotary electrode element;
 - c. the rotary electrode element comprising means defining a generally disk shaped member incorporating electrode surface of conducting material, drive means integral said disk shaped member separated encumberably from the electrode surface, said rotary electrode element mounted with associated journal and bearing means on the spindle element

assembly, rotatable therearound in a plane normal to the axis thereof in the area adjacent the ring defining means of the spindle assembly and located with the circular knife edge of the ring extended beyond the electrode surface;

- d. the stationary electrode element comprising means defining a regular plate member incorporating a smooth conductive electrode surface at least equivalent to the area of the rotatable electrode surface, said plate member pierced with a centrally located circular opening of diameter sufficient for snug insertion of tubular element projected toward but separated from fiber twisting component, said tubular element having an inside diameter sufficient to pass the twisting congruent with clearance;
 - e. the rotary twist control element assembly comprising a yarn twisting element with means to impart twist to and allow passage of yarn, said element rotated to remove twist in coring yarn between said yarn twisting element and said spindle element assembly, drive means integral said yarn twisting element, said yarn twisting element axially aligned with said spindle element assembly mounted with associated journal and bearing means between stationary electrode and yarn winder;
 - f. the coring yarn assembly comprising means for storing and delivering a coring yarn at a controlled rate, feeding means to feed said coring yarn past rotatably mounted guide rolls through axis of rotation of said pierced spindle element assembly of the electrostatic fiber collecting and yarn spinning apparatus through rotatably mounted guide rolls and terminating on any type textile package;
 - g. the first driving means adapted to turn the rotatable electrode element at a speed sufficient to insure uniform distribution of the fibers across the electrode and insure a rate of fiber transport adequate for yarn production;
 - h. the second driving means adapted to turn the spindle element assembly at a speed at least equal to the speed of the rotatable electrode element;
 - i. the third independent driving means adapted to turn the rotary twist control element assembly.
 - j. means for driving coring yarn assembly;
 - k. the supporting and positioning means adapted to support and maintain the electrode surface of the rotatable electrode element in a facing position adjacent the electrode surface of the stationary electrode element, spaced adjustably from the circular knife edge of the fiber collecting ring over a range coincident the length of the fibers being processed.
5. An apparatus with a rotary twist control element assembly for peripherally surfacing a coring yarn with individual fibers to produce a core yarn with a smooth appearance which comprises:
- a. a stationary electrode element with a tubular projection, a rotary electrode element, means adapted to establish and maintain an electrostatic potential gradient between the electrode elements, a spindle element assembly, a rotary twist control element assembly, and a coring yarn assembly, a first isolated driving means for turning the rotary electrode element, a second isolated driving means for turning the spindle element assembly, a third isolated driving means for turning the twist control element assembly, a fourth isolated driving means for the coring yarn assembly, associated supporting and

- positioning means for the several elements, and associated electrical circuitry for establishing and maintaining the electrostatic potential gradient;
- b. said spindle element assembly comprising means defining an elongated cylindrical member pierced with a centrally located circular passage of diameter sufficient to pass a coring yarn with clearance with one end integral said second driving means, and the other end terminating in nonconducting means defining a smooth rod shaped fiber twisting component, with a centrally located circular passage beginning at its base and terminating on its periphery and an upper circular passage beginning on its periphery and terminating at the axial center of its free end, a first central portion immediately adjacent the fiber twisting component ring concentrically encompassing and extending radially from the base of the fiber twisting component, said ring terminating axially toward the free end of the fiber twisting component in a circular knife edge, a second central portion immediately adjacent said ring incorporating journal and bearing means adapted to support axially and radially the rotary electrode element;
- c. the rotary electrode element comprising means defining a generally disk shaped member incorporating electrode surface of conducting material, drive means integral said disk shaped member separated encumberably from the electrode surface, said rotary electrode element mounted with associated journal and bearing means on the spindle element assembly, rotatable therearound in a plane normal to the axis thereof in the area adjacent the ring defining means of the spindle assembly and located with the circular knife edge of the ring extended beyond the electrode surface;
- d. the stationary electrode element comprising means defining a regular plate member incorporating a smooth conductive electrode surface at least equivalent to the area of the rotatable electrode surface, said plate member pierced with a centrally located circular opening of diameter sufficient for snug insertion of tubular element projected toward but separated from fiber twisting component, said tubular element having an inside diameter sufficient to pass the twisting congruent with clearance;
- e. The rotary twist control element assembly comprising a yarn twisting element with means to impart twist to and allow passage of yarn, said element rotated to remove twist in coring yarn between said yarn twisting element and said spindle element assembly, drive means integral said yarn twisting element, said yarn twisting element axially aligned with said spindle element assembly mounted with associated journal and bearing means between stationary electrode and yarn winder.
- f. the coring yarn assembly comprising means defining a coring yarn selected from the group consisting of any type staple fiber and any type monofilament on a spindle rotatably mounted on any conventional breaking means, feeding means to feed said coring yarn past rotatably mounted guide rolls through axis of rotation of said pierced spindle element assembly of electrostatic fiber collecting and yarn spinning apparatus through rotatably

- mounted guide rolls and terminating on any type textile package;
- g. the first driving means adapted to turn the rotatable electrode element at a speed sufficient to insure uniform distribution of the fibers across the electrode and insure a rate of fiber transport adequate for yarn production;
- h. the second driving means adapted to turn the spindle element assembly at a speed at least equal the speed of the rotatable electrode element;
- i. the third independent driving means adapted to turn the rotary twist control element assembly;
- j. means for driving coring yarn assembly;
- k. the supporting and positioning means adapted to support and maintain the electrode surface of the rotatable electrode element in a facing position adjacent the electrode surface of the stationary electrode element, spaced adjustably from the circular knife edge of the fiber collecting ring over a range coincident the length of the fibers being processed.
6. An apparatus with a rotary twist control element assembly for peripherally crosslinking a coring yarn with individual fibers to produce a bulky core yarn with durable press, antisoilable, and mildew and flame resistant properties which process comprises:
- a. a stationary electrode element with a tubular projection, a rotary electrode element, means adapted to establish and maintain an electrostatic potential gradient between the electrode elements, incorporating fiber collecting and fiber twisting component, a spindle element assembly, a rotary twist control element assembly, a coring yarn assembly and means for impregnating and curing a coring yarn, a first electrically isolated driving means for turning the rotary electrode element, a second isolated driving means for turning the spindle element assembly, a third isolated driving means for turning the twist control element assembly, a fourth and fifth synchronized driving means for feeding and winding the coring yarn, associated supporting and positioning means for the several elements and associated electrical circuitry for establishing and maintaining electrostatic potential gradient;
- b. said spindle element assembly comprising means defining an elongated cylindrical member with a centrally located circular passage of diameter sufficient to pass a coring yarn with clearance with one end integral said second driving means, and the other end terminating in nonconducting means defining a smooth centrally pierced rod shaped fiber twisting component, a first central portion immediately adjacent the fiber twisting component incorporating conductive means defining an integral fiber collecting ring concentrically encompassing and extending radially from the base of the fiber twisting component, said ring terminating axially toward the free end of the fiber twisting component in a circular knife edge, a second central portion immediately adjacent said ring incorporating journal and bearing means adapted to support axially and radially the rotary electrode element;
- c. the rotary electrode element comprising means defining a generally disk shaped member incorporating electrode surface of conducting material, drive means integral said disk shaped member separated encumberably from the electrode surface, said rotary electrode element mounted with associated

- journal and bearing means on the spindle element assembly, rotatable therearound in a plane normal to the axis thereof in the area adjacent the ring defining means of the spindle assembly and located with the circular knife edge of the ring extended beyond the conic electrode surface;
- d. the stationary electrode element comprising means defining a regular plate member incorporating a smooth conductive electrode surface at least equivalent to the area of the rotatable electrode surface, said plate member pierced with a centrally located circular opening of diameter sufficient for snug insertion of tubular element projected toward but separated from fiber twisting component, said tubular element having an inside diameter sufficient to pass the twisting congruent with clearance;
 - e. the rotary twist control element assembly comprising a yarn twisting element with means to impart twist to and allow passage of yarn, said element rotated to remove twist in coring yarn between said yarn twisting element and said spindle element assembly, drive means integral said yarn twisting element, said yarn twisting element axially aligned with said spindle element assembly mounted with associated journal and bearing means between stationary electrode and yarn winder.
 - f. means adapted for impregnating and curing the coring yarn;
 - g. the coring yarn assembly comprising means for storing and delivering coring yarn at a controlled rate, feeding means to feed said coring yarn through impregnating means past rotatably mounted guide rolls between squeeze and drive rolls into axis of rotation of said pierced spindle element assembly of the electrostatic fiber collecting and yarn spinning apparatus past rotatably mounted guide rolls through curing means and terminating on any type textile package;
 - h. the first driving means adapted to turn the rotatable electrode element at a speed sufficient to insure uniform distribution of the fibers across the electrode and insure a rate of fiber transport adequate for yarn production;
 - i. the second driving means adapted to turn the spindle element assembly at a speed at least equal to the speed of the rotatable electrode element;
 - j. the third independent driving means adapted to turn the rotary twist control element assembly.
 - k. the fourth and fifth synchronized driving means adapted for feeding and driving the coring yarn assembly;
 - l. the supporting and positioning means adapted to support and maintain the electrode surface of the rotatable electrode element in a facing position adjacent the electrode surface of the stationary electrode element, spaced adjustably from the circular knife edge of the fiber collecting ring over a range coincident the length of the fibers being processed.
7. An apparatus with a rotary twist control element assembly for peripherally crosslinking a coring yarn with individual fibers to produce a smooth core yarn with durable press, antisoilable, and mildew and flame resistant properties which process comprises:
- a. a stationary electrode element with a tubular projection, a rotary electrode element, means adapted to establish and maintain an electrostatic potential gradient between the electrode elements, incorpo-

- rating fiber collecting and fiber twisting component, a spindle element assembly, a rotary twist control element assembly, a coring yarn assembly and means for impregnating and curing a coring yarn, a first electrically isolated driving means for turning the rotary electrode element, a second isolated driving means for turning the spindle element assembly, a third isolated driving means for turning the twist control element assembly, a fourth and fifth synchronized driving means for feeding and winding the coring yarn, associated supporting and positioning means for the several elements and associated electrical circuitry for establishing and maintaining electrostatic potential gradient;
- b. said spindle element assembly comprising means defining an elongate cylindrical member pierced with a centrally located circular passage of diameter sufficient to pass coring yarn with clearance with one end integral said second driving means, and the other end terminating in nonconducting means defining a smooth rod shaped fiber twisting component with a centrally located circular passage beginning at its base and terminating on its periphery and an upper circular passage beginning on its periphery and terminating at the axial center of its face end, a first central portion immediately adjacent the fiber twisting component incorporating conductive means defining an integral fiber collecting ring concentrically encompassing and extending radially from the base of the fiber twisting component, said ring terminating axially toward the free end of the fiber twisting component in a circular knife edge, a second central portion immediately adjacent said ring incorporating journal and bearing means adapted to support axially and radially the rotary electrode element;
 - c. the rotary electrode element comprising means defining a generally disk shaped member incorporating electrode surface of conducting material, drive means integral said disk shaped member separated encumberably from the electrode surface, said rotary electrode element mounted with associated journal and bearing means on the spindle element assembly, rotatable therearound in a plane normal to the axis thereof in the area adjacent the ring defining means of the spindle assembly and located with the circular knife edge of the ring extended beyond the electrode surface;
 - d. the stationary electrode element comprising means defining a regular plate member incorporating a smooth conductive electrode surface at least equivalent to the area of the rotatable electrode surface, said plate member pierced with a centrally located circular opening of diameter sufficient for snug insertion of tubular element projected toward but separated from fiber twisting component, said tubular element having an inside diameter sufficient to pass the twisting congruent with clearance;
 - e. the rotary twist control element assembly comprising a yarn twisting element with means to impart twist to and allow passage of yarn, said element rotated to remove twist in coring yarn between said yarn twisting element and said spindle element assembly, drive means integral said yarn twisting element, said yarn twisting element axially aligned with said spindle element assembly mounted with

associated journal and bearing means between stationary electrode and yarn winder;
f. means adapted for impregnating and curing the coring yarn;
g. the coring yarn assembly comprising means for storing and delivering coring yarn at a controlled rate, feeding means to feed said coring yarn through impregnating means past rotatably mounted guide rolls between squeeze and drive rolls into axis of rotation of said pierced spindle element assembly of electrostatic fiber collecting and yarn spinning apparatus past rotatably mounted guide rolls through curing means and terminating on any type textile package;
h. the first driving means adapted to turn the rotatable electrode element at a speed sufficient to insure uniform distribution of the fibers across the electrode and insure a rate of fiber transport adequate for yarn production;

i. the second driving means adapted to turn the spindle element assembly at a speed at least equal the speed of the rotatable electrode element;
j. the third independent driving means adapted to turn the rotary twist control element assembly;
k. the fourth and fifth synchronized driving means adapted for feeding and driving the coring yarn assembly;
l. the supporting and positioning means adapted to support and maintain the electrode surface of the rotatable electrode element in a facing position adjacent the electrode surface of the stationary electrode element, spaced adjustably from the circular knife edge of the fiber collecting ring over a range coincident the length of the fibers being processed.

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