

[54] **ELECTROSTATIC FIBER
COLLECTING AND YARN SPINNING
APPARATUS**

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[58] Field of Search **57/58.89-58.95**

[56] **References Cited**

UNITED STATES PATENTS

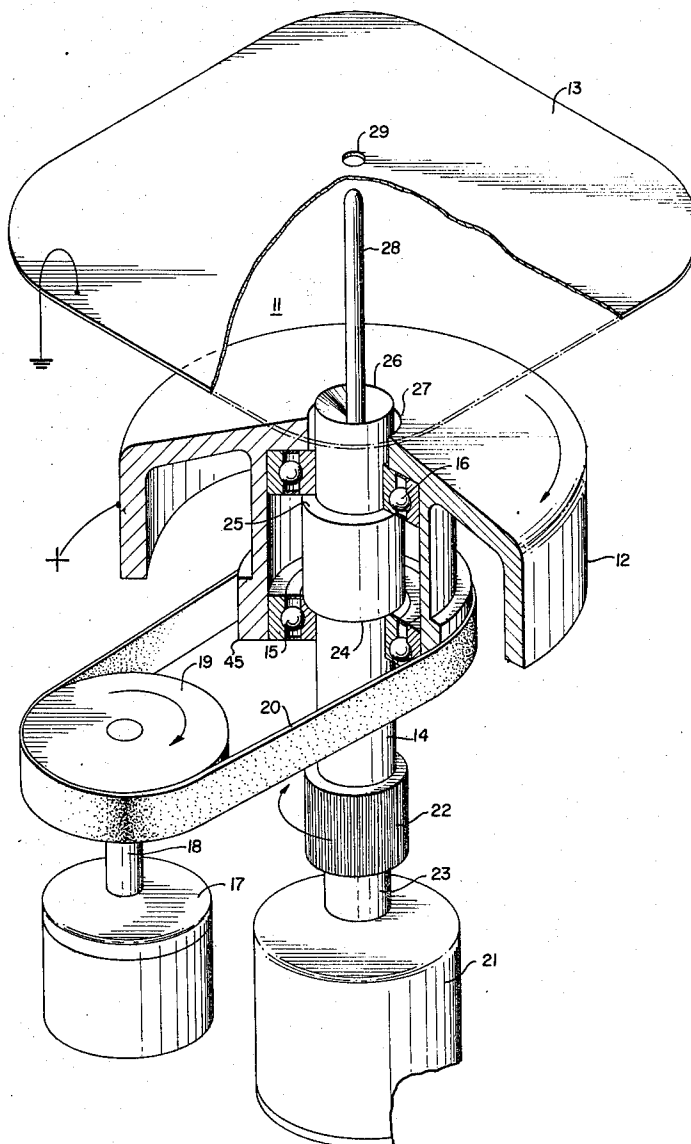
3,411,284 11/1968 Corbaz et al.57/58.91
3,552,112 1/1971 Chabot.....57/58.89

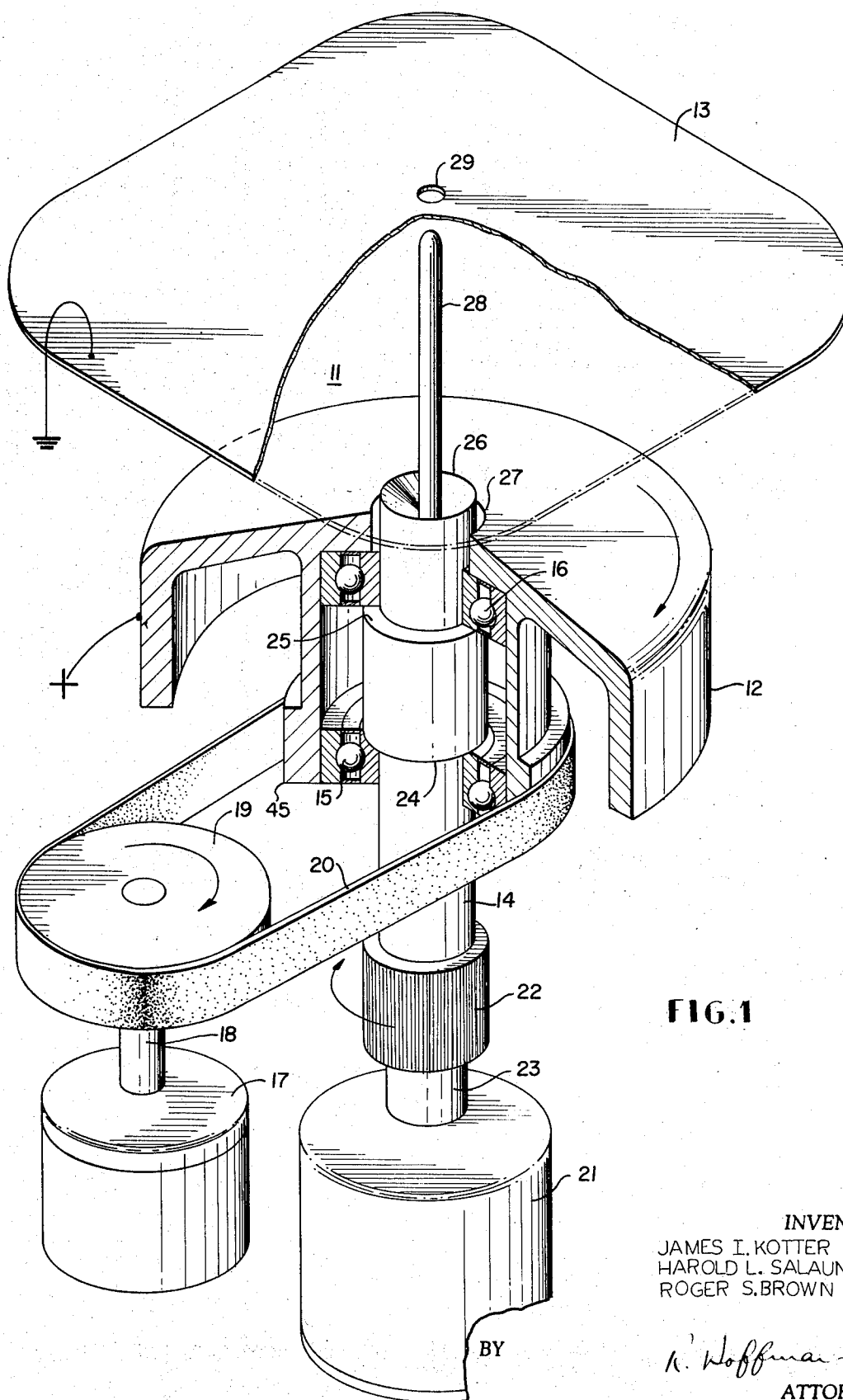
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[57] **ABSTRACT**

By combination and interaction of electrostatic and mechanical forces, airborne opened fibers are transported, parallelized, collected en masse and twisted to continuously form a high quality textile yarn. The invention also relates to a method and apparatus for continuous formation of a variety of yarns from the basic fiber spinning apparatus.

5 Claims, 5 Drawing Figures





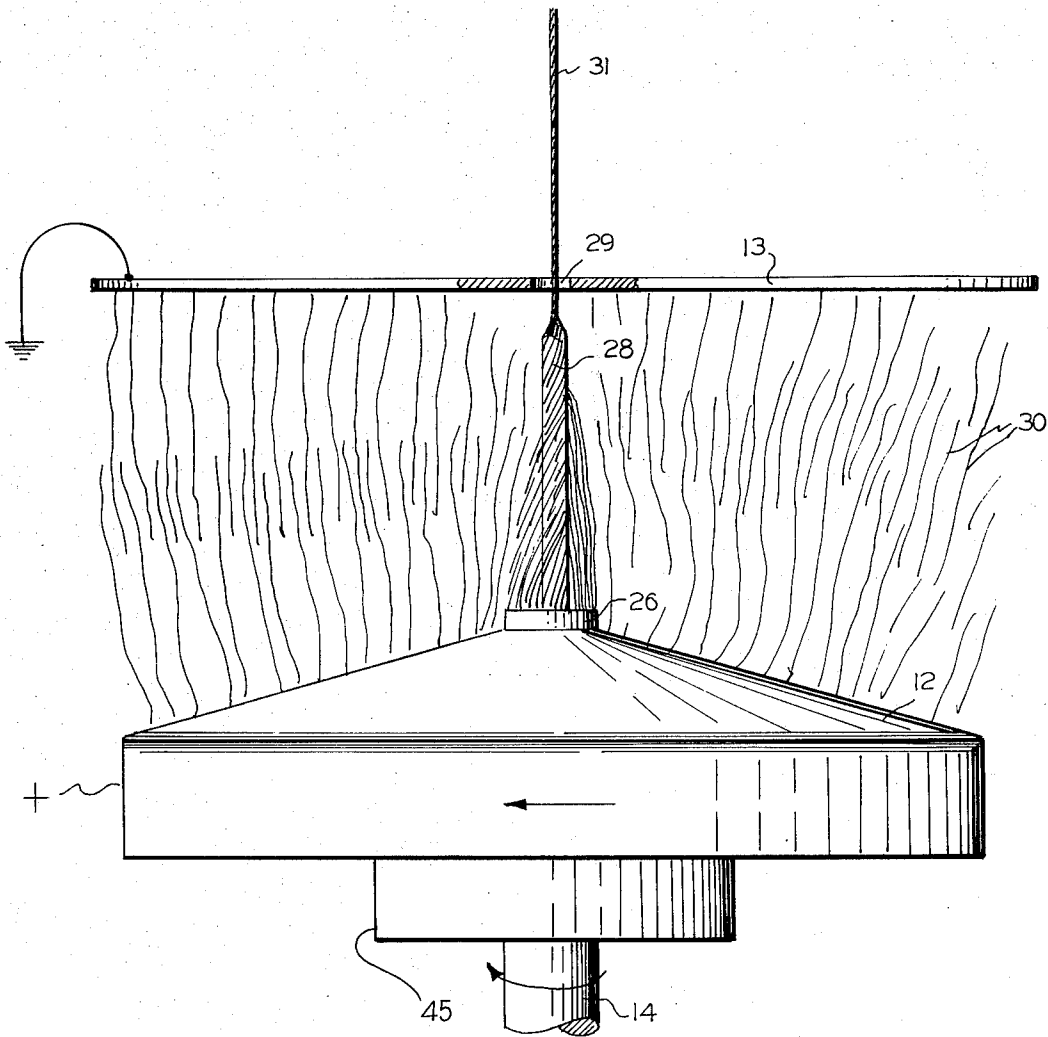


FIG. 2

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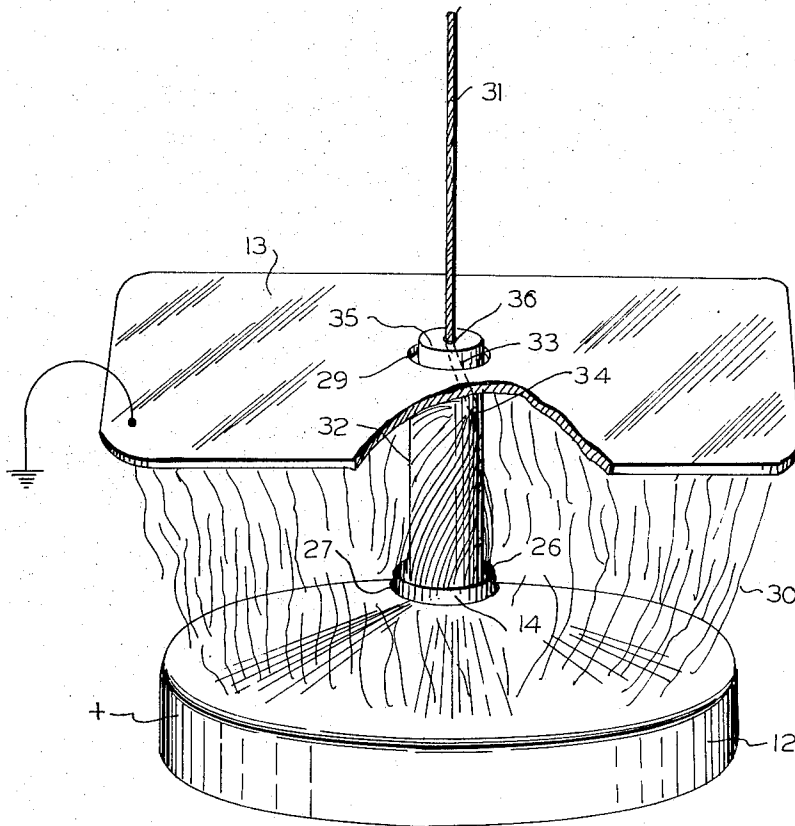


FIG. 3

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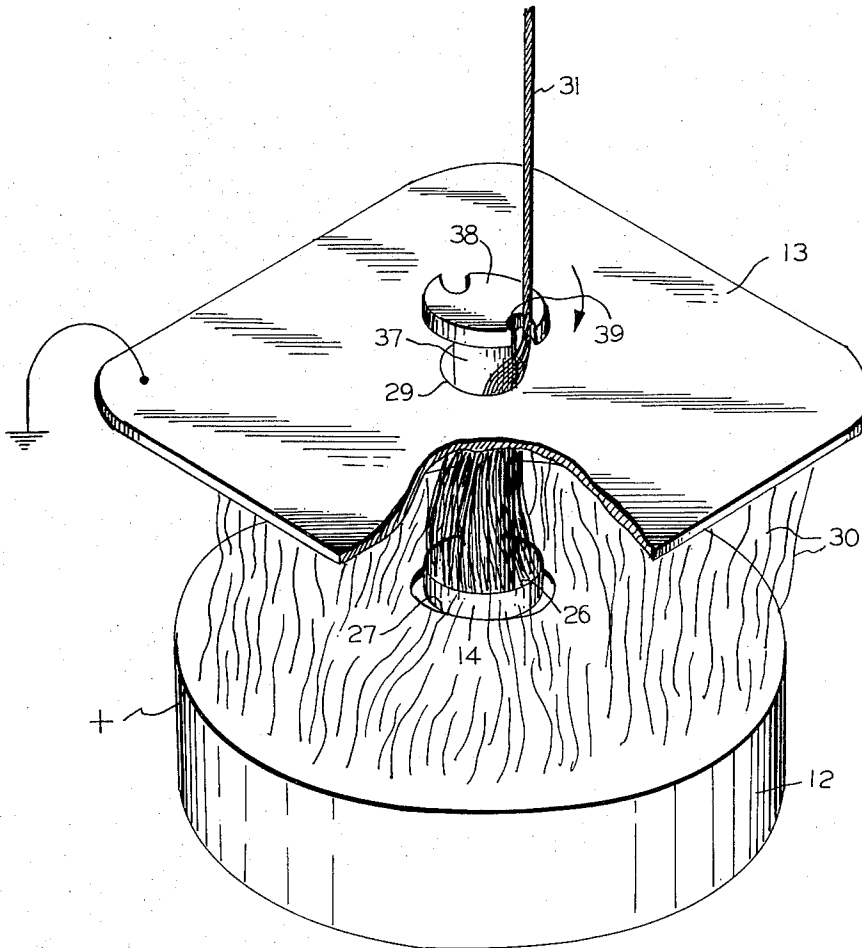


FIG. 4

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ELECTROSTATIC FIBER COLLECTING AND YARN SPINNING APPARATUS

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.

This invention relates to apparatus for continuously forming yarn from opened fibers.

More specifically, it relates to apparatus for completely removing spinnable fibers from an airstream, transporting, parallelizing, collecting them en masse, and imparting twist to the mass to form a high quality textile yarn.

Still more specifically, it relates to apparatus wherein the formed yarn is immediately wound into "cone" or "cheese" textile packages.

The apparatus of the present invention can be used to make a variety of yarns from open fibers by merely interchanging spindle elements.

To those experienced in the art of textile processing, it is common knowledge that conventional methods of yarn production consist of many preparatory processing steps requiring numerous intricately designed machines, considerable labor and a great expanse of textile mill floor area.

An object of this invention is to simplify the textile processing system by eliminating many of the processing steps now employed prior to spinning, without sacrificing yarn quality.

Another object of this invention is to eliminate production restriction as imposed on the spinning process by the ring-spinning method and to permit higher yarn production heretofore impossible even with open-end spinning devices.

Another object of the invention is to simplify the spinning operation by eliminating machines containing complicated drawing, spinning and winding mechanisms.

Another object of this invention is to provide a fiber spinning means from which the formed yarn is immediately wound into "cone" or "cheese" textile packages, thus eliminating the need for rewinding on cross-winding machines.

Another object of the invention is to provide a simple "quick change" means of spinning a variety of yarns from the same basic fiber spinning apparatus.

This invention is based on a unique method of yarn production in which well opened or separated fibers are supplied by any acceptable means, such as the opening apparatus described in U.S. Patent application Ser. No. 50,217, filed June 26, 1970, which is capable of processing raw stock, sliver, or roving. Opened fibers are conveyed, for example, by air to an electrostatic field formed and sustained by two electrodes, one of which is composed of two components, a conical element and a spindle (with a non-conducting twisting element), both separately revolving at controlled different speeds about a common axis. The other electrode is a stationary flat plate, located at a distance from the spindle (knife-edge ring) slightly none than the staple length of the fiber being processed (approximately 1½ inch). It is provided with an opening extending axially there-through from which the newly formed yarn is withdrawn from the spindle.

Upon entering the electrostatic field, the fibers become aligned parallel to the lines of force produced by the potential gradient, (i.e., 10 kv. to 60 kv). By a unique combination and interaction of electrostatic and mechanical forces, the parallelized fibers are rapidly transported to the centrally located relatively faster revolving spindle onto which a non-conducting twisting element is centrally attached. The speed at which the fibers move inwardly to the spindle projection is dependent on the rotational speed of the conical electrode.

The maximum electrostatic field strength is between the conducting, circular knife-edge of the spindle and the flat plate electrode. Because of its position and shape, the knife edge collects and holds the fibers in a circular array momentarily, as the yarn is being formed. The non-conducting spindle projection serves as a stable base upon which the incoming fibers orderly consolidate, and also as the twisting means for forming the fibers into yarn.

The size of the yarn is controlled by the rate at which the fibers are introduced into the electrostatic field and the rate at which the yarn is withdrawn through the opening of the flat plate electrode.

Excellent operation results with rotational speed of the conical electrode ranging from 1,000 to 3,000 r.p.m. Faster fiber transportation will result beyond 3,000 r.p.m.; however, beyond this velocity air currents are a hindering factor. Spindle rotational speed is governed only by mechanical limitations, providing a means for achieving extremely high production rates.

For low production application, the rotational speeds of the conical electrode and the spindle may be the same.

A model of the invention operated successfully with a 6 inch diameter conic electrode and a one-half inch spindle, producing 18's yarn at a production rate over 20 yards per minute. However, it will be readily apparent that the invention is not limited by the stated dimensions or production rate.

Further objects and advantages of the invention will be apparent from the following specifications and drawings.

In the drawings:

FIG. 1 is a partially schematic three-dimensional view of the apparatus with portions broken away to show internal construction.

FIG. 2 is a partially schematic partial side view of the apparatus depicting yarn formation.

FIG. 3 is a partially schematic three-dimensional partial view of the apparatus depicting yarn formation with a different type twisting element.

FIG. 4 is a partially schematic three-dimensional partial view of the apparatus depicting yarn formation with still another type twisting element.

FIG. 5 is a schematic view of the apparatus shown in conjunction with a fiber opening device.

FIG. 1 illustrates our apparatus in which conical electrode 12 is rotatably mounted, axially and radially supported by spindle 14, through bearings 15 and 16, and independently driven by variable speed motor 17, through motor shaft 18, pulleys 19 and 45, and nonconducting belt 20. Spindle 14 is also rotatably mounted and is independently driven by high speed motor 21 to which it is coupled by means of non-conducting

coupling 22 and motor shaft 23. Spindle 14 supports conical electrode 12 by means of protruding bearing surfaces 24 and 25.

Spindle 14 is constructed with a conducting knife-edge ring 26, extending axially through opening 27 of electrode 12 and terminating slightly above the surface of electrode 12.

Attached to and extending axially from spindle 14 is a non-conducting twisting element 28.

To provide an adequate electrostatic field for complete removal of fibers from the airstream, flat-plate electrode 13 is constructed sufficiently large to extend beyond periphery of electrode 12. Electrode 13 is provided with opening 29 axially aligned with twisting element 28.

Although non-conducting twisting element 28 is shown located a slight distance from axially aligned opening 29, of flat plate electrode 13, the apparatus is operative with twisting element 28 constructed to lengths resulting in its termination point before, coincident with, or extended beyond opening 29.

Electrode 12 is energized, for example, by a standard DC power supply (not shown) with 10 kilovolts to 60 kilovolts at 2 milliamperes maximum current through conventional wire and slide contacting means. The flat plate electrode 13 is electrically grounded. Reversed polarity does not affect the operation of the apparatus.

Although the stationary electrode 13 is described in this embodiment as being flat, it may be dished, concave, or convex.

The invention is not so limited to the rotary electrode 12 being conical in shape; the apparatus is workable with a flat or rounded rotary electrode.

The apparatus operates equally well with conical electrode 12 and the spindle 14 rotating in either direction, clockwise or counterclockwise, providing a simple means for producing yarn with "S" or "Z" twist.

The apparatus is also operable with conical electrode 12 rotating clockwise as spindle 14 rotates counterclockwise or vice versa.

Although the apparatus is illustrated in the upright position, is operative in any position.

Referring to FIGS. 1 and 2, in operation, separated fibers and fed into the electrostatic field 11 from any horizontal position circumscribing the apparatus, within boundaries limited by conical electrode 12 and flat plate electrode 13.

By a unique combination of mechanical and electrical forces caused by the rotary action of conical electrode 12 and the electrostatic field 11, the fibers are completely removed from the airstream, aligned parallel with the field force lines and rapidly transported, individually and uniformly, to the highest field intensity located between rotating knife-edge ring 26 of spindle 14 and stationary electrode 13. At this instant the fibers contact non-conducting twisting element 28. Twisting element 28 serves as a stable base upon which the fibers 30 consolidate, and it is the twisting means whereby the fibers 30 are twisted into yarn 31. Continuously, and in rapid succession, the fibers 30 are uniformly assembled, joined together with preceding fibers 30, twisted, and removed axially as yarn from twisting element 28, through opening 29 of electrode 13. Immediately thereafter, yarn 31 is wound into any type textile package such as a "cone" or a "cheese," et cetera, by conventional winding methods.

Referring to FIGS. 1, 2, 3, and 4: Spindle 14 is designed to accommodate various types of non-conducting twisting elements 28, 32, 37, etc., each of which produces a particular type of yarn 31.

Referring specifically to FIG. 3, twisting element 32, attached to spindle 14 is cylindrical in shape and has a passage 33, which begins on its longitudinal periphery at point 34, extends internally at an angle toward the end of the twisting element, and terminates axially through its flat end surface 35 at point 36. In operation, as the spindle rotates at high speed, the fibers 30, are continually drawn through passage 33 of twisting element 32, entering at point 34 and exiting at point 36 as yarn 31.

Referring to FIG. 4, a twisting element 37, attached to spindle 14 is constructed as shown. Fibers are transported to the circular ring 26 of spindle 14, as previously described. Similarly, twisting element 37 is a base on which the fibers 30 consolidate. By its high speed rotary action, and by means of its yarn holding configuration 38, the fibers 30 are twisted and drawn through semicircular passage 39 as yarn 31.

A twisting element 37 with its yarn holding configuration 38 produces a yarn 31 of relatively good strength, good fiber parallelization, good uniformity and gives a "furry" appearance; whereas a twisting element 32 produces a smooth yarn of relatively good strength, good fiber parallelization, and good uniformity.

FIG. 5 schematically illustrates our apparatus in conjunction with a fiber opening and feeding means 40 capable of processing raw stock, sliver, and/or roving 41. Fibers 30 are continuously discharged from fiber opener 40 and conveyed by air to electrostatic field 11. By the unique combination of electrostatic and mechanical forces, the fibers 30 are continuously transported, aligned, collected en masse, and twisted into yarn 31 as previously explained.

Plate electrode 13 is adjustably mounted by means of slidable clamp 42 on rod 43 which is connected to base 44. Plate electrode 13, connected to clamp 42 is locked in desired position by means of thumb-screw 45.

Variable-speed motors, 17 and 21, are mounted to base 44.

Other spindle element configurations and variations thereof may be successfully utilized, for example a smooth conical element, an axially fluted conical element, a spirally fluted conical element, a conical element with a peripheral to apex passage, et cetera.

By interchanging various, specifically designed, non-conducting twisting elements, a large selection of yarn types can be produced from basically the same spinning apparatus.

We claim:

1. Yarn spinning apparatus comprising:

- a. a stationary electrode, a rotatable electrode spaced from the stationary electrode rotatable in a plane parallel to that of the stationary electrode, and means connected to said electrodes for establishing and maintaining an electrostatic field between them, said rotatable electrode having an axial opening therethrough, said stationary electrode having and opening axially aligned with the opening in the rotatable electrode;
- b. a rotatable, elongated, hollow, cylindrical, electrically-conductive spindle having a nonconductive

fiber twisting member secured to one end thereof and extending axially from said end of said spindle, said same end of the spindle terminating in a sharp-edged, fiber collecting ring which concentrically encompasses the base of the fiber twisting member, said fiber collecting ring extending through the axial opening in the rotatable electrode coaxially therewith;

c. bearing means for mounting the rotatable electrode on the spindle whereby said electrode can rotate freely about said spindle;

d. means for adjusting the distance between the two electrodes while maintaining the opening in the stationary electrode in axial alignment with the rotational axis of the rotating electrode;

e. separate driving means connected to said spindle and to said rotatable electrode whereby said spindle and said electrode can be rotated independently of each other at different speeds, said electrode driving means being adequate to rotate the rotatable electrode at a speed sufficient to insure uniform distribution of fibers supplied to the space between the electrodes and to insure a rate of fiber transport adequate for yarn production; and

f. means for continuously withdrawing yarn spun from said fibers by said fiber-twisting member through the opening in the surface of the stationa-

ry electrode.

2. The apparatus of claim 1 wherein the rotatable electrode has a conical surface of electrically conducting material and the stationary electrode comprises a plate member having a smooth conductive surface of an area equivalent at least to the area of the rotatable electrode, the stationary electrode being spaced from the knife edge of the fiber collecting ring on the spindle a distance corresponding to the length of the fibers being processed.

3. The apparatus of claim 1 wherein the fiber-twisting member comprises an elongated nonconducting, smooth-surfaced rod.

4. The apparatus of claim 1 wherein the fiber-twisting member comprises an elongated, nonconducting smooth-surfaced cylinder having an internal beginning on its longitudinal periphery and terminating at the axial center of the free end of said fiber-twisting members.

5. The apparatus of claim 1 wherein the fiber-twisting component comprises an elongated, nonconducting, smooth-surfaced rod terminated by an elliptically shaped, radially disposed disc with opposed hook-like appendages extending from the long axis of the elliptical disc, said disc extending beyond the periphery of the cylindrical spindle.

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