Dec. 16, 1952 V. G. FORZLEY ET AL 2,622,182

APPARATUS FOR DRYING CONTINUOUS FILAMENT YARN AND THE LIKE

Filed June 23, 1951 2 SHEETS—SHEET 1

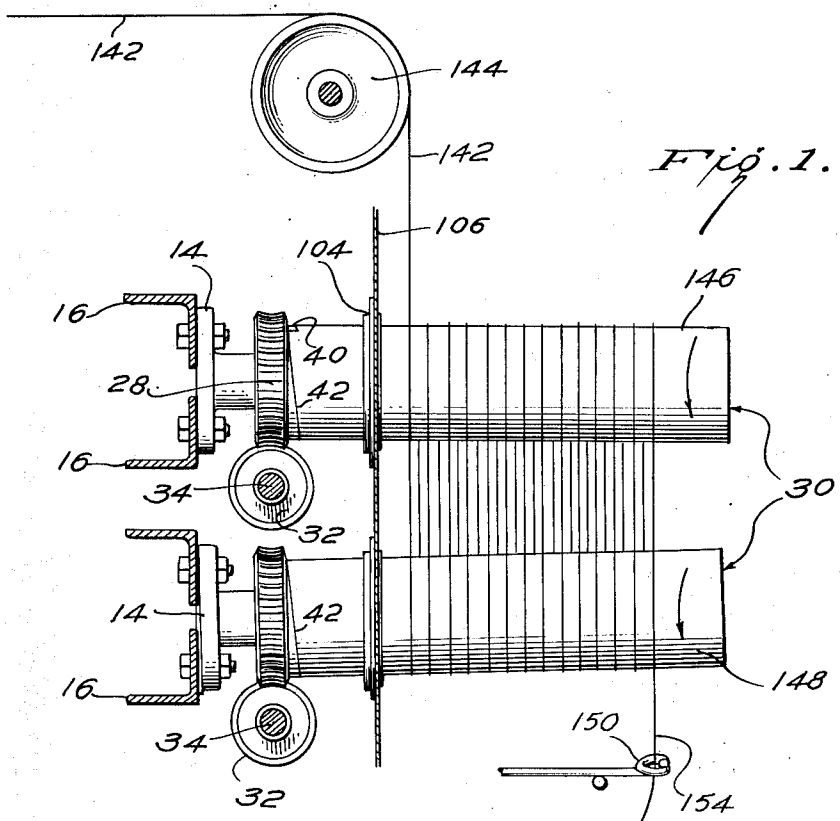
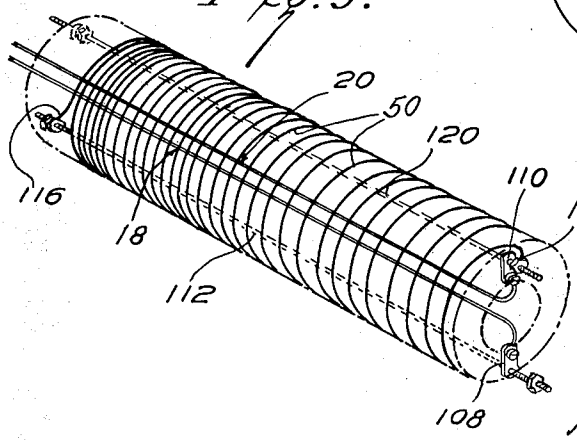


Fig. 1.

Fig. 5.



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2 SHEETS—SHEET 2

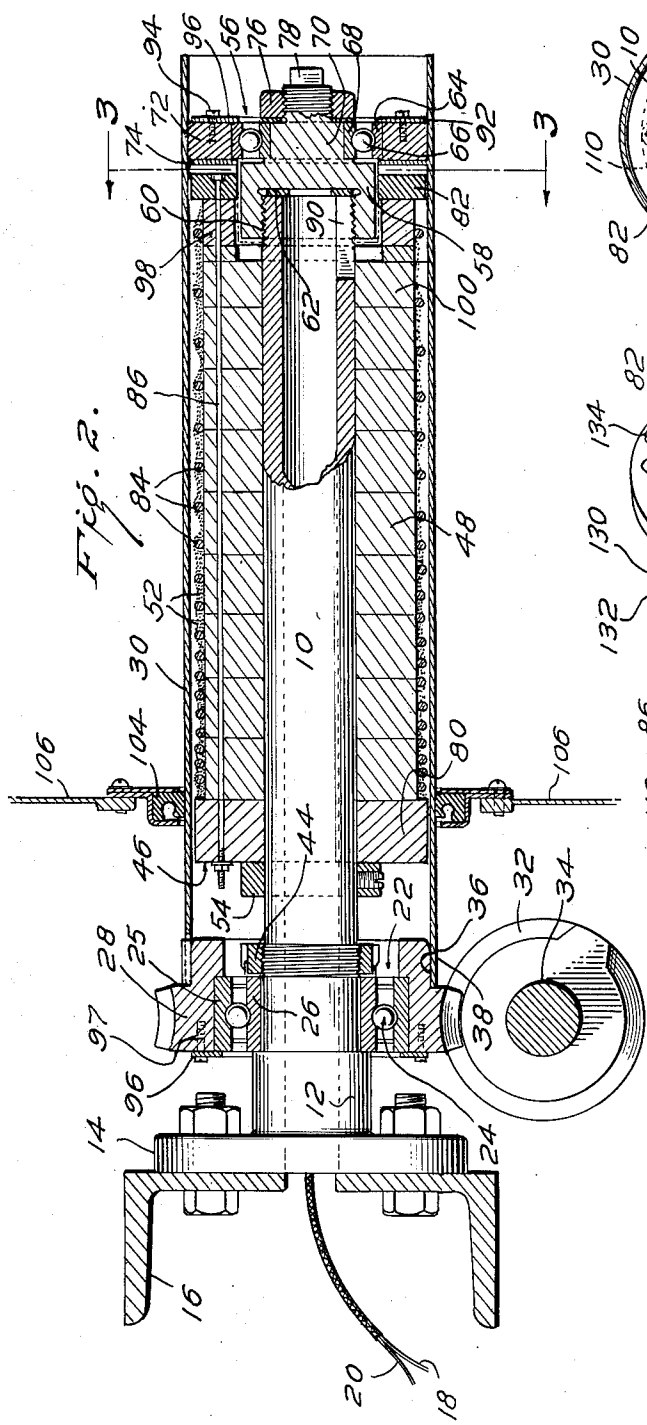

Fig. 2.

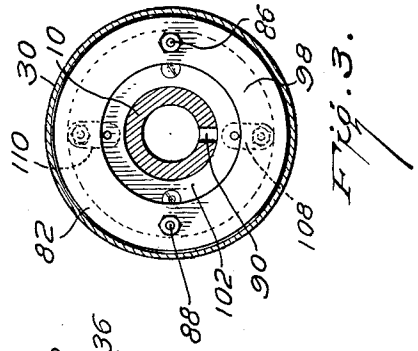

Fig. 3.

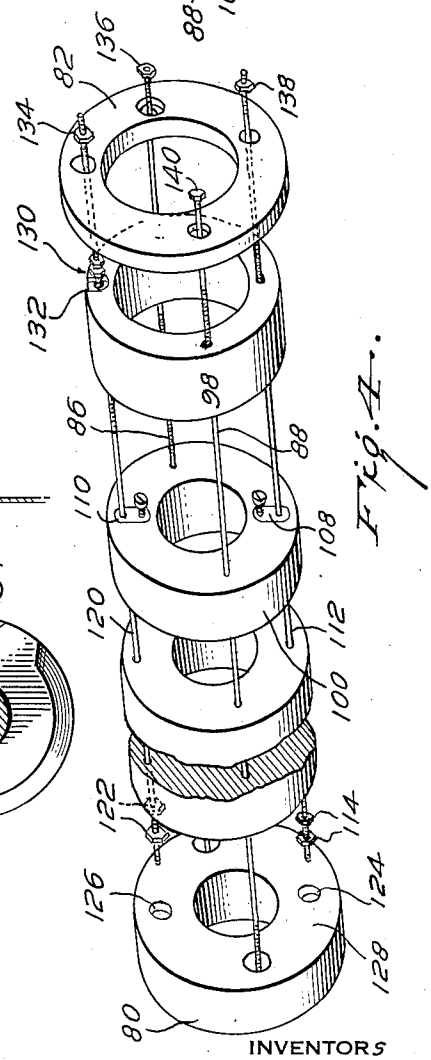

Fig. 4.

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APPARATUS FOR DRYING CONTINUOUS FILAMENT YARN AND THE LIKE

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Application June 23, 1951, Serial No. 233,154

4 Claims. (Cl. 219—19)

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This invention relates broadly to apparatus for drying a continuous length of an elongated article such, for instance, as continuous filament yarns, as well as rods, tapes, ribbons, bands and other elongated articles in wet state. It is concerned more particularly with such apparatus whereby wet or moist continuous filament yarn or the like is continuously dried while passing over an electrically heated, thread-storage, thread-advancing device comprising a pair of spaced, converging, cantilevered, rotatable, hollow (preferably cylindrical) rolls which are preferably suspended in the same vertical plane. When this device is in operation the continuous filamentary material or other elongated article advances from the feed-on end to the take-off end of the rolls.

The apparatus of the present invention is useful in the drying of wet-spun filamentary material in continuous length, such as the various viscose, cuprammonium and acetate rayons in the form of continuous filaments, fibers or threads; also, gelled filaments, fibers or threads formed of an acrylonitrile polymerization product, e. g., those produced in the manner described and claimed in the copending application of Arthur Cresswell, Serial No. 772,200, filed September 4, 1947, now Patent No. 2,558,730, dated July 3, 1951; and natural filaments or threads or other forms of an elongated article that require a drying treatment. As indicated in the preceding paragraph, the apparatus also can be used in drying such articles when in the form of rods, tapes, bands, ribbons and the like.

Several different forms of apparatus were known or suggested, prior to our invention, for continuously drying filamentary material and the like. For instance, in Kline et al. Patent No. 2,222,817 it is suggested that thread be dried on a thread-advancing reel, which is electrically heated internally and which embodies two interdigitating reel members having relative movement during rotation of the reel and each of which is made up of a plurality of spaced, longitudinally extending, thread-bearing elements. Also, in Uytenbogaart et al. Patent No. 2,244,745 it is suggested that a continuous length of yarn, thread or the like be dried by passage over a pair of spaced, rotatable cylinders, one of which is electrically heated by means of an internally disposed, stationary, tapered, heating element which is in axial alignment with the axis of rotation of the cylinder. It was also known prior to our invention to use, for continuously drying a wet thread or the like, spaced, rotatable, converging drying rolls which were heated by radiation from electrical strip heaters positioned within the rolls (reference: Cresswell copending application Serial No. 73,078, filed January 27, 1949, which is now a Patent No. 2,558,731, granted July 3, 1951, and Cresswell and Wizon copending application Serial No. 97,786, filed June 8, 1949, which is now Patent No. 2,558,733, granted July 3, 1951).

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The present invention provides new and improved apparatus for continuously drying wet or moist filamentary material and other elongated articles that has numerous practical advantages over similar apparatus heretofore suggested or used in the art. For example, the construction of the apparatus permits rapid dismounting of the roll and accompanying internal heating unit from the gripping surface of the drive gear to which the roll is disengageably attached, and which is done without shutting off the power. Hence other drying rolls which are similarly connected through gears to the same source of power or to a common drive shaft can continue to function. Furthermore, the heating unit itself can be rapidly and easily removed from the roll and the roll re-fitted with a new or repaired unit when necessary. Also, the heating unit is so constructed that there is a highly effective distribution of heat upon the surface of the roll; more particularly there is a greater concentration of heat at the feed-on end of the rolls and a lesser concentration of heat at the take-off end of the rolls. Since the spaced, converging rolls are cantilevered, that is, they are supported at one end and unsupported at the other end, with no obstruction such as conduits, supports, etc., at the unsupported or open end, the construction makes possible easy cleaning of the surfaces of the rolls when necessary, as well as simplifying the problem of dismounting the rolls for servicing while the spinning machine is in operation.

The novel features of our invention are set forth in the appended claims. The invention itself, however, will be understood most readily from the following detailed description thereof when considered in connection with the accompanying drawing, which is illustrative of a preferred embodiment of the invention, and in which

Fig. 1 is a somewhat schematic, side elevational view showing a pair of spaced, converging, cantilevered, rotatable, drying rolls embodying our invention; and further showing a continuous filament leading to the feed-on end of the rolls

from a supply source, passing over the rolls to the take-off end, and thence to a bobbin for collection of the dry filament;

Fig. 2 is a view which is partly a vertical longitudinal section, partly broken away and partly in side elevation, and which shows one of the drying rolls with the heating unit positioned in place within the roll, the driving mechanism for the roll and the supporting structure for a stationary shaft upon which the heating unit and roll are mounted;

Fig. 3 is an end view taken on the line 3—3 of Fig. 2;

Fig. 4 is a perspective view of part of the heating unit shown in Fig. 1, with portions thereof shown as being pulled apart for purpose of clarity, and broken in the middle; and

Fig. 5 is a perspective view of the main body portion (end members are not shown) of the general form of heating unit illustrated in Fig. 1, showing the winding of the resistance element upon the outer periphery of the unit.

Referring to the drawing and especially to Fig. 2 thereof, a hollow, stationary shaft 10 having an extension 12 is welded or otherwise secured to a flange 14 that is bolted or otherwise rigidly fastened to a supporting frame 16, so that the shaft 10 is cantilevered. This shaft is adapted to receive lead-in wire 18 and return wire 20 for conducting electrical current. The angle of the shaft 10 to the horizontal can be adjusted, in order to provide a desired angle of convergency between the spaced rolls, by any suitable means, for example by inserting a shim between the flange 14 and the frame 16.

A rear bearing assembly 22 comprising bearings 24, moving bearing sleeve 25 and dead ring or stationary bearing sleeve 26 supports the drive gear 28 which drives or rotates the roll 30. The gear 28 in turn is driven by engaging gear 32 attached to a common shaft 34 which drives other similar units. The drive gear 28 has a gripping surface 36 for engaging or gripping the roll 30 at its rear end 38. Alternatively, or in addition to the gripping surface 36, the gear 28 can be provided with a key 40 (Fig. 1) which can be caused to engage a locking edge or device 42 (Fig. 1) in the rear end of the roll 30. A lock nut 44 secures the dead ring or stationary bearing sleeve 26 in position.

The roll 30 (Figs. 1 and 2) is provided with a removable, hollow, electrical heating unit 46 (Fig. 2) snugly fitted and held in position upon the hollow, stationary shaft 10 within the roll. This heating unit comprises a hollow insulating cartridge 48; a winding 50 (Fig. 5) of an electrical resistance element extending along the outer periphery of the main body portion of the cartridge 48 and closely adjacent, but not contacting, the portion of the roll which is to be heated; and suitable electrical connections of copper or other conducting metal which are suitably positioned within the said heating unit for making the necessary connections between the ends 116 and 118 of the winding 50 and the lead-in wire 18 and the return wire 20. The winding 50 is so positioned upon the outer periphery of the main body portion of the cartridge 48 that there is a greater concentration of heat at the feed-on end and a lesser concentration of heat at the take-off end of the roll.

The insulating cartridge 48 can be made, if desired, as a unitary structure from any suitable insulating material or combination of insulating materials, e. g., from asbestos or an asbestos-containing composition, or a suitable combination of asbestos and mica with or without other insulating materials; or preformed, matching rings or annular sections of such insulating material or materials can be assembled to form the insulating cartridge. If desired, the outer surface of the cartridge 48 upon which the winding 50 rests can be surfaced with bonded mica sheet insulation or equivalent material.

The cartridge 48 is positioned at its rear end by means of the collar 54 which is secured to shaft 10 by a set screw. A suitable header adapted to receive a front bearing assembly 56 is removably attached to the front end of the hollow, stationary shaft 10. This header advantageously may take the form, as shown, of a head nut 58 which is threaded to externally threaded end 60 of the stationary shaft 10. The head nut 58 presses the roll 30 onto the gripping surface 36. A suitable deformable washer 62, made for example of lead, between the facing edge of the threaded end 60 and the seat of the head nut 58 provides means for increasing the grip of the roll 30 on the gripping surface 36, since the washer 62 is easily deformed as the head nut 58 is tightened.

The front bearing assembly 56 comprises moving bearing sleeve 64, bearings 66 and dead ring or stationary bearing sleeve 68. It is dressed on the extension 70 of the head nut 58 and, in combination with the insulating end member 72, formed for example of laminated cloth, comprises a support for the roll 30 at its front end. The annular member or diaphragm 74, formed for instance of metal, is attached, as by welding, to the inner end portion of roll 30 and aids in holding the insulating end member 72 and the moving bearing sleeve 64 in position. The lock nut 76 is threaded upon the threaded extension 78 and secures the stationary bearing sleeve 68 in position. A washer 92, formed for instance of metal, or other suitable retaining member, is suitably attached, as by means of a plurality of screws 94, to the insulating end member 72 and, in combination with the diaphragm 74, aids in securing the moving bearing sleeve 64 in position.

The moving bearing sleeve 25 of the rear bearing assembly 22 is secured in position by the washer 96 formed of metal or other suitable material. The washer 96 is suitably attached, as by means of the screws 97, to the drive gear (for the roll) 28.

The rear end member 80 and the front end member 82 of the cartridge 48 advantageously are slightly larger in overall diameter than the main body portion of the cartridge, thereby facilitating the winding of the helices of the electrical resistance element 84 upon the outer periphery of the cartridge and minimizing the possibility of damage to the winding or any loosening or displacement of the positioned helices during handling, e. g., while installing the individual units.

If the insulating cartridge 48 is formed of a plurality of relatively thick rings instead of in the form of a unitary structure, such rings may be fastened together by any suitable means, for instance by a plurality of metallic tie rods or long bolts extending lengthwise through the structure. One such tie rod 86 is shown in Fig. 2, while tie rod 86 and a second tie rod 88 are shown in Figs. 3 and 4.

The hollow stationary shaft 10 is provided with a slot 90 near its front end as shown. The lead-in wire 18 and return wire 20 are passed through this

slot to suitable electrical connections, such as those shown by way of illustration in Figs. 3 and 4, for making the necessary connections between the said wires and the ends of the winding 50.

The bore of the front piece 98 of the cartridge 48 is larger in diameter than that of the rearward members, including the adjacent rearward piece 100, thereby forming a recess adapted to receive the head nut 58, and also forming the edge 102 (Fig. 3).

A suitable seal 104 attached by any suitable means to the frame 106 prevents any gear lubricant from passing onto the heating surface of the roll and contaminating the material which is being dried thereon. It also prevents any antistatic agent or other treating fluid that is applied to the material being dried from flowing to the rear of the roll.

Referring now more particularly to Figs. 4 and 5 for a description of wiring connections: the lead-in wire 18 is attached to the contact member 108 and the return wire 20 to the contact member 110. The incoming electrical current passes through the rigid conductor 112, e. g., a copper rod, to the contact point or connections 114, e. g., a pair of nuts threaded onto the threaded end of the conductor 112, and to which the rearward end 116 (Fig. 5) of the winding 50 of the resistance wire, e. g., Nichrome wire, is attached through a suitable opening in the wall of the cartridge 58. The resistance wire is wound around the outer periphery of the insulating cartridge as indicated generally in Fig. 5. In this figure (Fig. 5) the forward end 118 of the winding 50 is shown as being attached to the contact member 110, in which case the last helix or helices of the resistance wire are around the outer periphery of the piece or ring 100 of the insulating cartridge 48. Since, in the preferred construction, the cartridge 48 is provided with a rigid conductor 120 and a contact point or connections 122 corresponding to members 112 and 114, respectively, no particular care need be taken, in making electrical connections when installing the cartridge, to be sure that the lead-in and return wires are attached to a particular terminal. The advantages of this feature will be immediately apparent to those skilled in the art. Recesses 124 and 126 are provided in the facing edge 128 of the rear end member 80 of the cartridge 48 for receiving the ends of the connections 114 and 122, respectively.

It is shown in Fig. 4 that connections 130, which may be a pair of threaded nuts, can be provided for connecting the forward end of the winding 50 to the conductor 120. The slot 132 in the wall of the cartridge 48 provides a convenient means for passing the end of the resistance wire to the connections 130. A similar slot and connections (not shown) are generally provided on the opposite side for use when the lead-in and return wires are connected in the reverse direction from that hereinbefore described, in which case the end of the resistance wire, after the last turn has been made on the outer periphery of the front piece 98 of the cartridge, is connected to the conductor 112. When the cartridge is assembled, the nuts 134, 136, 138, and 140 are so screwed upon the corresponding threaded conductors or tie rods that they recede into the corresponding recesses or openings provided in the front end member 82 of the cartridge 48. Nut 134 can be omitted, if desired, when the connections 130 comprise a pair of threaded nuts as shown in Fig. 4. The ends of these nuts are then flush with the front or facing surface of the front end member 82 of the cartridge, or slightly below said surface. If necessary, the nuts 134 (if present), 136, 138 and 140 may be soldered to the respective rods or conductors on which they are threaded, thereby holding them firmly in position after assembly of the cartridge and during operation of the roll; or, a pair of nuts and an intervening washer may be used on each threaded rod or conductor in firmly attaching the nuts in position; or instead of using threaded rods or conductors as shown, long bolts having a head which is integral with the one end of the rod portion of the bolt can be used. After the nuts have been tightened or soldered in position, the recesses or openings provided in the end member 82 for receiving them are usually filled in with a suitable hardenable insulating cement, e. g., a ceramic binder.

In winding the electrical resistance element 84 upon the outer periphery of the cartridge 48, the spacing between individual helices or turns is such that there is greater concentration of heat, when the unit is being operated, at the rear end and lesser concentration of heat at the front end. The following is illustrative of spacing between turns which, of course, will vary depending, for example, upon the nature of the material being dried upon the rolls and the speed at which it is being advanced over the surface of the roll from the feed-on end to the take-off end; and, also, of the general arrangement of the winding.

Taking as an example an insulating cartridge with an overall length of 10 inches and a diameter of about 3¼ inches, the winding may be started, for instance, 1 inch from the back end of the cartridge; eleven turns are then made with a spacing of ¼ inch between turns followed by nine turns with a spacing of $\frac{5}{16}$ inch between turns, and leaving about 3¼ inches of the cartridge length at the front end on which three turns are made with increasing spacing therebetween. In such a winding the total length of wire is, for instance, 20 feet. The wire is nichrome wire of a suitable gauge for the particular purpose, for example, 26 gauge Nichrome wire, with a resistance of about 2.64 ohms per foot. The winding, of course, may be spaced between turns in various other ways so long as there is a greater concentration of heat at the feed-on end of the roll and a lesser concentration of heat at the take-off end of the roll. Thus, the spacing between each turn or between each set of every two or three uniformly spaced turns may be increased so that the greatest concentration of heat is at the feed-on end of the roll and then there is a more gradual lessening of heat as the article to be dried advances toward the take-off end of the roll.

The winding is held in place by means of, for example, a suitable adhesive or binder 52, which may be, for instance, a ceramic binder that is applied at several points along the length of the portion of the roll with the winding thereon.

Referring now to Fig. 1: As there shown, a wet elongated article 142 to be dried, e. g., continuous filamentary material such as a stretched, gelled fiber or multifilament thread of an acrylonitrile polymerization product, is led from a supply source (not shown) over the guide roll 144 to the feed-on ends of the upper roll 146 and the lower roll 148. The wet filamentary material or other elongated article is wrapped about the pair of rolls to form a plurality of helices, and is then led continuously under tension through a guide 150 to a suitable take-up device.

for instance a twister bobbin such, for example, as the ring twister 152 whereby the dried, elongated article 154, more particularly filamentary material, is twisted and collected on the bobbin 156. The rolls 146 and 118 are driven at the same peripheral speed by suitable driving mechanism, such as that shown in Fig. 1 by way of illustration.

One or both of the rolls 146 and 148 are slightly inclined (i. e., converge) toward each other at the delivery end thereby to advance the filamentary material or the like over the rolls. The rolls are suitably spaced from each other, e. g., 6 or 8 inches or more, and preferably are suspended in the same vertical plane. The degree of convergency between the rolls may be varied as desired or as conditions may require in order to advance the thread or the like over the rolls; for instance, with rolls 4 inches in diameter and 10 inches long, satisfactory results have been obtained by having the lower roll convergent to the upper roll, at the delivery end, so that the angle was about 0.6°.

The rolls 146 and 148 may be made of any suitable material such, for example, as Monel metal, stainless steel, aluminum, chromium-plated copper, chromium-plated steel, anodized aluminum, dense graphite, fused quartz, glass, resin-impregnated glass-fiber laminate, etc. The rolls are preferably smooth-surfaced and made of a material which is a good heat conductor, that is, a material which will permit the rapid transfer of heat from the internal surfaces to the external surfaces of the roll.

The drying apparatus of our invention is especially adapted for use in apparatus employed in the manufacture of synthetic elongated articles, e. g., synthetic fibers such as those formed from polymeric or copolymeric acrylonitrile, and especially apparatus of the kind disclosed and claimed in the copending application of Arthur Cresswell and Irvin Wizon, Serial No. 212,929, filed February 27, 1951, as a division of copending application Serial No. 97,786, filed June 8, 1949, which is now Patent #2,553,733, granted July 3, 1951. Our invention provides more uniformly dried thread than heretofore normally has been obtained in drying, for example, a gelled monofilament or multifilament of an acrylonitrile polymerization product since, for one reason, the greatest amount of heat contacts the gelled filamentary material at the point where it contains the larger amount of moisture. The drying unt has relatively few moving parts, and hence wear on parts is reduced to a minimum and the service life of the unit is prolonged. Furthermore, the construction lends itself to economical fabrication in a shop, which means that manufacturing costs are reduced to a minimum. Other advantages of the invention have been pointed out in the fourth paragraph of this specification.

We claim:

1. Apparatus adapted for drying a continuous length of an elongated article compriisng a pair of spaced, converging, cantilevered, rotatable, hollow rolls whereby in operation the said article advances from the feed-on end to the take-off end of said rolls; means for rotating each of the rolls of the said pair at the same peripheral speed; a hollow, stationary, cantilevered shaft extending lengthwise within each of said rolls, said shaft being adapted to receive lead-in and return wires; and a removable, hollow, electrical heating unit snugly fitted and held in position upon the said shaft within each of said rolls, said heating unit including (*a*) a hollow insulating cartridge, (*b*) a winding of an electrical resistance element extending along the outer periphery of said cartridge and closely adjacent to the portion of the roll which is to be heated, said resistance element being positioned upon the periphery of said cartridge and so wound thereon that, in operation, there is a greater concentration of heat at the feed-on end of the rolls and a lesser concentration of heat at the take-off end of the rolls, and (*c*) electrical connections within the said heating unit for making the necessary connections between the ends of the said winding and the said lead-in and return wires.

2. Apparatus adapted for drying a continuous length of filamentary material comprising a pair of spaced, cantilevered, rotatable, hollow, cylindrical, converging rolls suspended in the same vertical plane, whereby in operation the said filamentary material advances from the supported, feed-on end to the unsupported, take-off end of said rolls; means for rotating each of the rolls of the said pair at the same peripheral speed, said means including front and rear bearing assemblies located near the front and rear ends of each of said rolls; a hollow, stationary, cantilevered shaft extending lengthwise within each of said rolls, said shaft being adapted to receive lead-in and return wires; a hollow insulating cartridge snugly fitted and held in position upon the said shaft within each of said rolls; a winding of an electrical resistance element extending along the outer periphery of said cartridge and closely adjacent to the portion of the roll which is to be heated, said resistance element being positioned upon the periphery of said cartridge and so wound thereon that, in operation, there is a greater concentration of heat at the feed-on end of the rolls and a lesser concentration of heat at the take-off end of the rolls; electrical connections, including an electrical conductor extending lengthwise through the main body portion of said cartridge, for making the necessary connections between the ends of the said winding and said lead-in and return wires; a header removably attached to the front end of each of said stationary shafts and being adapted to receive the aforementioned front bearing assembly; and means for retaining each of the said front and rear bearing assemblies in position.

3. Apparatus comprising, in combination, a cantilevered, rotatable, hollow drying roll; a hollow, stationary, cantilevered shaft extending lengthwise within said roll, said shaft being adapted to receive lead-in and return wires; and a removable, hollow, electrical heating unit snugly fitted and held in position upon the said shaft within said roll, said heating unit including (*a*) a hollow insulating cartridge, (*b*) a winding of an electrical resistance element extending along the outer periphery of said cartridge and closely adjacent to the portion of the roll which is to be heated, said resistance element being positioned upon the periphery of said cartridge and so wound thereon that, in operation, there is a greater concentration of heat at the feed-on end of the roll and a lesser concentration of heat at the take-off end of the roll, and (*c*) electrical connections within the said heating unit for making the necessary connections between the ends

of the said winding and the said lead-in and return wires.

4. A drying unit for use in apparatus adapted for drying a continuous length of filamentary material comprising, in combination, a cantilevered, rotatable, hollow, cylindrical drying roll; a hollow, stationary, cantilevered shaft extending lengthwise within said roll, said shaft being adapted to receive lead-in and return wires; means adapted to permit rotation of said roll about said shaft, said means including front and rear bearing assemblies located near the front and rear ends of said roll; a hollow insulating cartridge snugly fitted and held in position upon the said shaft within the said roll; a winding of an electrical resistance element extending along the outer periphery of said cartridge and closely adjacent to the portion of the roll which is to be heated, said resistance element being positioned upon the periphery of said cartridge and so wound thereon that, in operation, there is a greater concentration of heat at the feed-on end of the roll and a gradual lessening of heat as the article to be dried advances toward the take-off end of the roll; electrical connections, including an electrical conductor extending lengthwise through the main body portion of said cartridge, for making the necessary connections between

the ends of the said winding and the said lead-in and return wires; a header removably attached to the front end of said stationary shaft and being adapted to receive the aforementioned front bearing assembly; and means for retaining each of the said front and rear bearing assemblies in position.

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