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THREAD-ADVANCING DRYING UNIT

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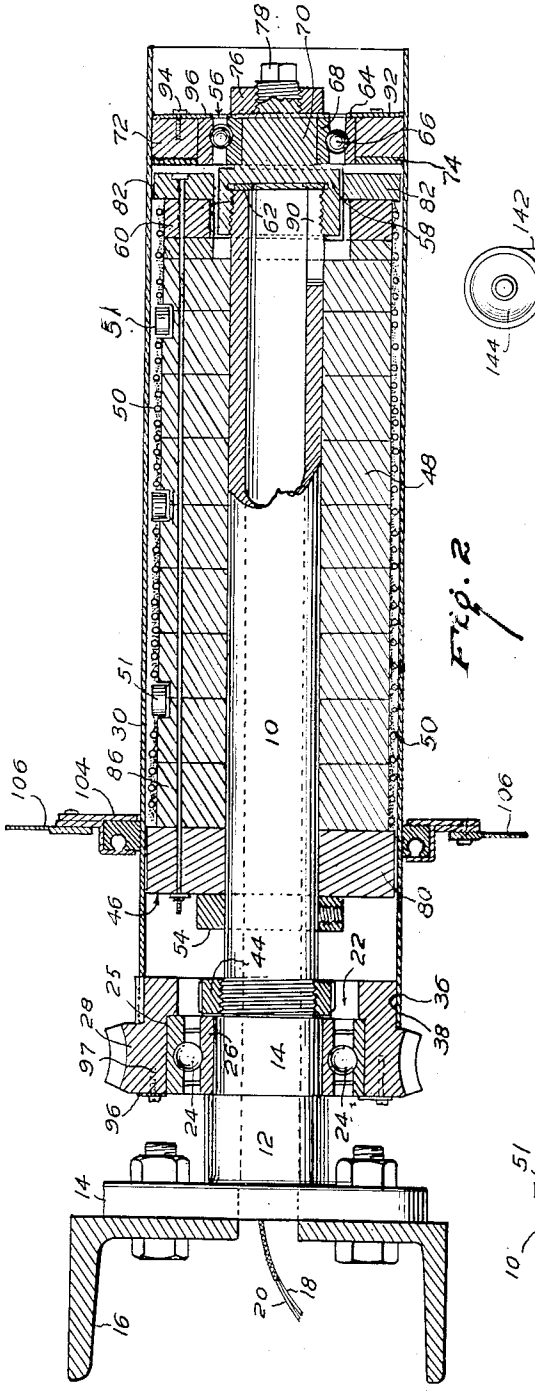

Fig. 2

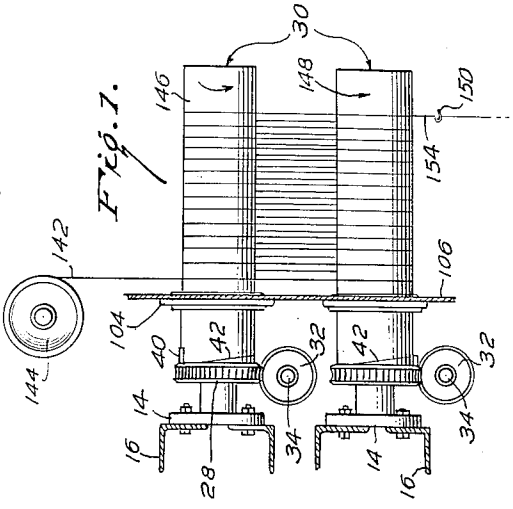

Fig. 1

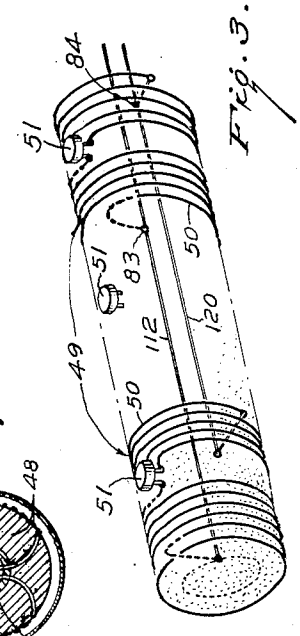

Fig. 3

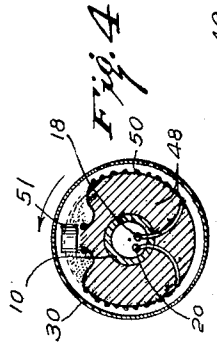

Fig. 4

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THREAD-ADVANCING DRYING UNIT

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1 Claim. (Cl. 219—19)

This invention relates broadly to apparatus for continuously drying a continuous length of a flexible, elongated particle such, for instance, as continuous filament yarns, tapes, ribbons, bands and other elongated articles in wet state. Such apparatus is often designated generally as a thread-advancing drying unit and is so designated herein and in the appended claim. The invention is concerned more particularly with 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 or unit 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 flexible 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 or moist filaments, fibers or threads formed of an acrylonitrile polymerization product, e. g., those produced in the manner described and claimed in Cresswell Patent No. 2,558,730, dated July 3, 1951; and natural filaments or threads or other forms of a flexible 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 are heated by radiation from electrical strip heaters positioned within the rolls (see Cresswell Patent No. 2,558,731 and Cresswell and Wizon Patent No. 2,558,733, each dated July 3, 1951).

In its broader aspects the present invention is directed to a thread-advancing drying unit comprising means for advancing a wet thread or the like over the external surfaces thereof and a heating unit closely adjacent to the surfaces of the said unit that are to be heated, which unit includes a plurality of separate windings of an electrical

resistance element and a thermostat connected to each of said separate windings for individually controlling the temperature thereof. Specifically our invention is directed to an improvement in the apparatus for drying continuous filament yarn and the like that is disclosed and claimed in Forzley and Sonnino Patent No. 2,622,182, dated December 16, 1952, whereby a more uniformly dried thread is obtained and, as a result thereof, a thread which is more uniform in its properties, e. g., in uniformity of luster.

The present invention provides new and improved apparatus for continuously drying wet or moist filamentary material and other flexible, elongated articles (herein sometimes generically designated as "thread" or "threads") that has numerous practical advantages over similar apparatus previously suggested or used in the art. For example, the construction of our apparatus provides all of the advantages of the invention disclosed and claimed in the aforementioned Patent No. 2,622,182 while at the same time it overcomes some of the disadvantages thereof. Thus, our thread-advancing drying unit permits rapid dismounting of the roll and accompanying internal heating unit from the gripping surface of the drive gear from 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 refitted 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 the heat can be adjusted so that at different points along the roll there are different zones of heat maintained at different temperatures which have been found to be the optimum for that particular point along the roll when drying a particular thread. 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.

Among the primary advantages flowing from our invention may be mentioned the fact that the invention provides automatic compensation for heat demand which varies with the rate of product travel, product size, moisture content and atmospheric conditions. Thus, by providing means for controlling the rate and amount of drying and the effect thereof on the finished thread, there is obtained a uniformity of separate filaments of the thread as formed on a one-place or on a multiple-place spinning machine. The overall effect is a substantial improvement in the quality of the dried thread as compared with that of similar threads dried by the known prior-art drying methods.

The novel features of our invention are set forth in the appended claim. The invention itself, however, will be understood most readily by the 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, cantileverd, rotatable, drying rolls embodying our invention; and further showing a continuous filament leading to the feed-on end of the roll from a supply source, passing over the rolls to the take-off end, and thence to collection means (not shown);

Fig. 2 is a view which is partly a vertical longitudinal

section, partly broken away and partly in side elevation, which shows one of the drying rolls with the heating unit positioned in place within the roll and the supporting structure for a stationary shaft upon which the heating unit and roll are mounted;

Fig. 3 is a perspective view of part of a heating unit embodying the invention, with two separate windings of an electrical resistance element shown (with one omitted) on the outer periphery thereof; and

Fig. 4 is a cross-sectional view of a part of a heating unit embodying the invention.

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 (Fig. 1) attached to a common shaft 34 (Fig. 1) 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 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 plurality of separate windings 49 (Fig. 3) 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; a thermostat 51 connected to each of said separate windings 49 for individually controlling the temperature thereof; and means including, for example, the rigid conductors 112 and 120 (Fig. 3), for connecting the ends of each of the said separate windings 49 to the lead-in wire 18 and the return wire 20. Alternatively, instead of using rigid conductors, as exemplified by conductors 112 and 120 in Fig. 3, in making the aforementioned connections to the lead-in wire 18 and return wire 20, the connections may be made as shown in Fig. 4. As there shown, the ends of the winding 49 (Fig. 3) are passed through openings in the cartridge 48 and connected directly to the lead-in wire 18 and return wire 20.

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 plurality of separate windings 49 rests can be surfaced with bonded mica sheet insulation or equivalent material. One suitable combination comprises a heat-reflective shield formed, for instance, of metal (e. g., sheet tin, tinned sheet iron, sheet aluminum or aluminum alloys, chromium-plated sheet steel, etc.) immediately adjacent to the outer periphery of the cartridge 48; a mat of glass cloth adjacent this reflective shield with the windings of the electrical resistance element depressed in this glass mat; and thereover a glass-cloth retainer to hold the windings of the electrical resistance elements securely in place. The use of glass cloth, bonded mica sheet or the like adjacent to the heating element provides a "heat bank" and evens out the distribution of the heat.

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 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 the 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 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 50 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.

The hollow stationary shaft 10 is provided with a slot 90 near its front end as shown. A lead-in wire 18 and return wire 20 are passed through the slot to suitable electrical connections, such as those shown by way of illustration in Fig. 3, for making the necessary connections between the said wires and the ends of each of the separate windings 49 as shown at 83 and 84 in Fig. 3. Or, as previously has been mentioned, the electrical connections may be made, if desired, as shown in Fig. 4.

For details of the construction of the insulating cartridge 48 when it is formed of a plurality of relatively thick rings instead of in the form of a unitary structure, reference is made to Fig. 4 of Patent No. 2,622,182, mentioned hereinbefore.

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.

It will be understood, of course, that insulating cartridge **48** may be slotted or grooved as may be required in order to pass the ends of the separate windings **49** therethrough and connect with the rigid conductors **112** and **120** (Fig. 3), which may be formed, for example, of a copper rod or other electrical conductor in suitable form.

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 continuously fed under tension through a guide **150** to a suitable take-up device, such for instance as a twister bobbin, more particularly a ring twister, whereby the dried, elongated article **154**, more particularly filamentary material, is twisted and then collected on the bobbin. The rolls **146** and **148** 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, anadized 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 unit of our invention is especially adapted for use in apparatus employed in the manufacture of synthetic, flexible, 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 Cresswell and Wizon Patent No. 2,614,289 dated October 21, 1952. 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 heat is accurately controlled so that there will be neither under-drying nor over-drying of the thread as it passes over the surfaces of the drying roll. The drying unit 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 this invention have been pointed out in the forepart of the specification.

Taking a gelled filament of an acrylonitrile polymerization product as illustrative of the wet thread to be dried, the present invention makes it possible for the temperature of the drying roll to be controlled so that there are separate drying zones wherein the drying roll temperature is, for example, as follows: 135° to 175° F. at the feed-on end of the drying roll, 130° to 160° F. in the middle of the drying roll and 115° to 140° F. at the take-off end of the drying roll.

We claim:

A thread-advancing drying unit comprising a pair of spaced, converging, cantilevered, rotatable, hollow rolls whereby in operation a wet thread or the like 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 plurality of separate windings of an electrical resistance element, said plurality of separate windings extending along the outer periphery of said cartridge and being closely adjacent to the portion of the roll which is to be heated, (*c*) a thermostat connected to each of said separate windings for individually controlling the temperature thereof, and (*d*) means for connecting the ends of each of the said separate windings to the said lead-in and return wires.

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